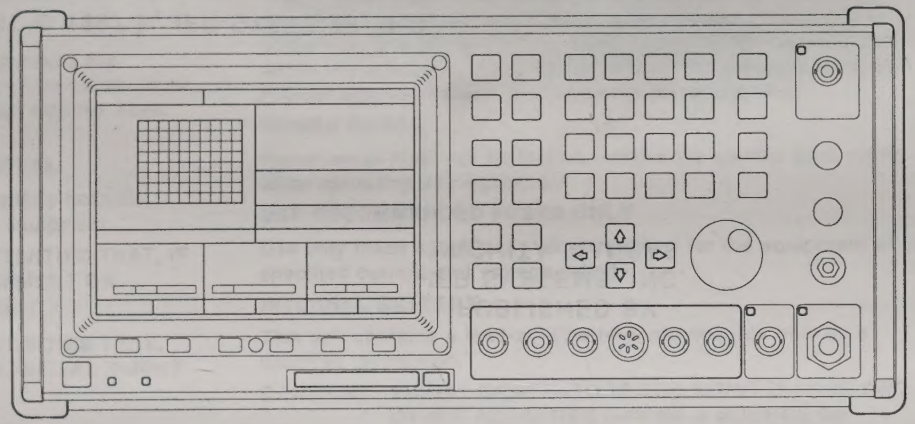
COM-120B
COMMUNICATIONS SERVICE MONITOR

4.50

SYSTEMS, INC.



APPLICATION GUIDE

1002-0600-500

PUBLISHED BY
IFR SYSTEMS, INC.
WICHITA, KANSAS

COPYRIGHT © 1997 by IFR SYSTEMS, INC.

All rights reserved. printed in the United States of America. No part of this publication may be reproduced in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.

SAFETY FIRST: TO ALL OPERATIONS PERSONNEL

REFER ALL SERVICING OF UNIT TO QUALIFIED TECHNICAL PERSONNEL. THIS UNIT CONTAINS NO OPERATOR SERVICEABLE PARTS.

WARNING: USING THIS EQUIPMENT IN A MANNER NOT SPECIFIED BY THE ACCOMPANYING DOCUMENTATION MAY IMPAIR THE SAFETY PROTECTION PROVIDED BY THIS EQUIPMENT.

CASE, COVER OR PANEL REMOVAL

Removing protective covers from the Test Set exposes the operator to electrical hazards that can result in electrical shock or equipment damage. Do not operate this Test Set with the case, cover or panels removed.

SAFETY IDENTIFICATION IN TECHNICAL MANUAL

The following terms draw attention to possible safety hazards, that may exist when operating or servicing this equipment.

CAUTION: IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN EQUIPMENT OR PROPERTY DAMAGE (E.G., FIRE).

WARNING: IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN PERSONAL INJURY OR DEATH.

SAFETY SYMBOLS IN MANUALS AND ON UNITS

⚠ CAUTION: Refer to accompanying documents.

∿ AC OR DC TERMINAL: Terminal that may supply or be supplied with ac or dc voltage.

⎓ DC TERMINAL: Terminal that may supply or be supplied with dc voltage.

∿ AC TERMINAL: Terminal that may supply or be supplied with ac or alternating voltage.

⏻ SWITCH ON/OFF (Push-Push): AC line power to the device is connected ON or disconnected OFF.

EQUIPMENT GROUNDING PRECAUTION

Improper equipment grounding can result in electrical shock.

USE OF PROBES

Check specifications for maximum voltage, current and power ratings of any connector on the Test Set before connecting a probe from a terminal device. Verify terminal device performs within these specifications before using it for measurement, to prevent electrical shock or damage to the equipment.

POWER CORDS

Power cords must not be frayed, broken nor expose bare wiring when operating this equipment.

USE RECOMMENDED FUSES ONLY

Use only fuses specifically recommended for the equipment at the specified current and voltage ratings.

INTERNAL BATTERY

This unit contains a lead-acid battery, serviceable only by a qualified technician.

CAUTION: SIGNAL GENERATORS FOR MAINTENANCE AND OTHER ACTIVITIES CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE (EMI) TO COMMUNICATION RECEIVERS. SOME TRANSMITTED SIGNALS CAN CAUSE DISRUPTION AND INTERFERENCE TO COMMUNICATION SERVICES OUT TO A DISTANCE OF SEVERAL MILES. USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION THAT RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND SHOULD TAKE NECESSARY PRECAUTIONS TO AVOID POTENTIAL COMMUNICATION INTERFERENCE PROBLEMS.

TABLE OF CONTENTS

TITLE	PAGE
INTRODUCTION	6
HOW TO USE THIS BOOK	6
INSTALLATION	7
Cable Statement, Power Up Procedures	7
Applying AC Power, Battery Power Operation, Applying External DC Power	7
CONTROLS, CONNECTORS AND INDICATORS	8
RECEIVER TESTING	16
Measuring Receiver Center Frequency, et al	17
Receiver Center Frequency	17, 18
12 dB SINAD Sensitivity	17, 19
Modulation Acceptance Bandwidth	17, 20
Measuring Receiver Audio Output Level	21
Measuring Receiver IF Bandwidth	23
Monitoring Paging Receivers	26
TRANSMITTER TESTING	30
Measuring Transmitter Harmonics	31

TABLE OF CONTENTS (Cont'd)

TITLE	PAGE
TRANSMITTER TESTING (Cont'd)	
Measuring Transmitter Frequency Error	34
Measuring Transmitter Distortion	37
Analyzing Intermod Distortion	40
Isolation and Insertion Loss	42
Monitoring DCS & CTCSS	43
DCS or CTCSS Generate	44
DCS or CTCSS Receive	45
How To Find An Unknown Transmitter Frequency	46
FILE SYSTEM OPERATION	48
How To Create A File	49
File Management	51
How To Retrieve A File	53
BATTERY FUSE REPLACEMENT	54
EXTERNAL CLEANING	55
SPECIFICATIONS	56

INTRODUCTION

This publication was developed to aid the communication service technician in using the COM-120B Communications Service Monitor to analyze certain common transmitter and receiver performance parameters *and* should be used in conjunction with the COM-120B Operation and TMAC Manuals. Tests included were selected because of appropriateness, application to as wide a spectrum of equipment as possible and minimum amount of auxiliary equipment required to perform the test.

The scope of this publication does not allow the inclusion of specific troubleshooting techniques, nor quarantee that the included tests are suitable for all applications. Consult material from the UUT manufacturer for specific test requirements or other appropriate tests.

HOW TO USE THIS BOOK

This Application Guide contains actual field applications of the COM-120B Communications Service Monitor.

The Application Guide is divided into three categories: Receiver Testing, Transmitter Testing and File System Operation.

Each Application is preceded by the name of the test and is comprised of a brief overview with highlights of the application.

There is a detailed test setup illustration following each Application.

Refer to the front and rear panel illustrations to identify the controls, connectors and indicators referenced in the Application Guide.

INSTALLATION

CABLE STATEMENT

For continued EMC compliance, double shielded and properly terminated external interface cables must be used with this equipment when interfacing with the RS-232, IEEE-488 GPIB and Reference Connectors.

POWER UP PROCEDURES

The Internal Battery, if installed, charges automatically whenever the COM-120B is connected to a power source and the Main Power Switch is ON. The Power Supply is designed to sense applied voltage and automatically compensate with no further actions required.

APPLYING AC POWER

1. Insure proper fuse is installed in AC FUSE Holder.
2. Connect power cord to AC Input Connector.
3. Plug cord into power source. Insure proper grounding.
4. Set Main Power Switch to ON ("I" on switch). Power APPLIED Indicator lights when power is available.
5. Press COM-120B Front Panel Power ON Key to activate unit. Power ON Indicator lights.

BATTERY POWER OPERATION

1. Press COM-120B Front Panel Power ON Key.
2. Power ON Indicator lights.

   Option 01 required for battery operation.

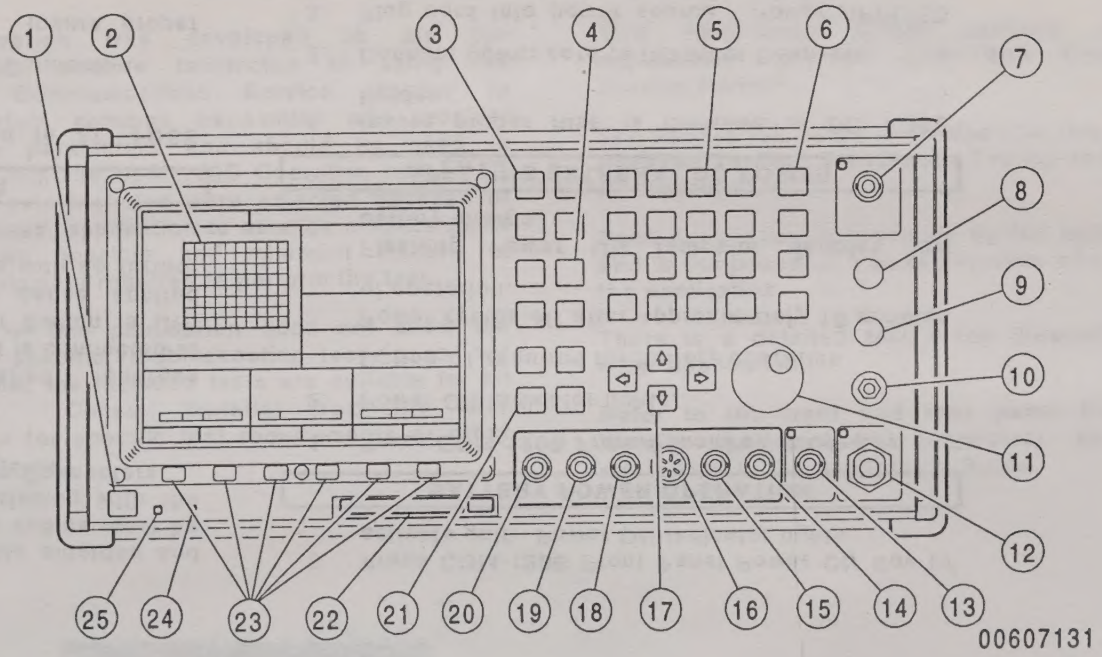
   Power cycles off after approximately 10 minutes of operation.

   Flashing Power ON Indicator denotes low battery charge.

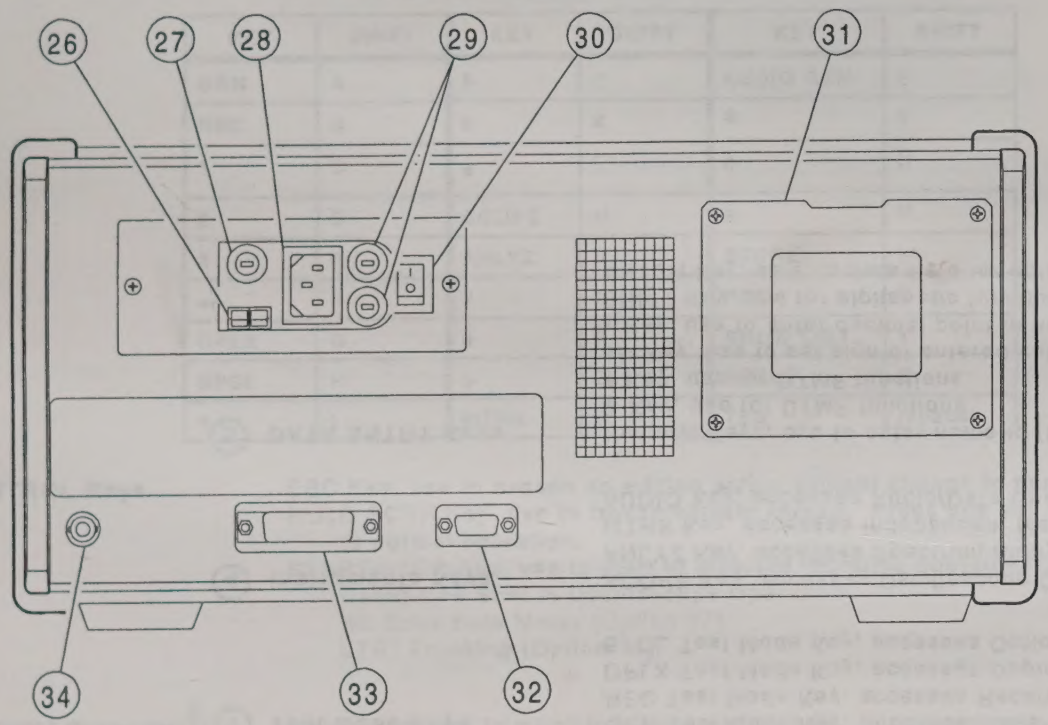
APPLYING EXTERNAL DC POWER

1. Insure proper fuse is installed in DC FUSE Holder.
2. Connect power cord to DC Input Connector.
3. Plug cord into power source. Power APPLIED Indicator lights when power is available.
4. Press COM-120B Front Panel Power ON Key to activate unit. Power ON Indicator lights.

CONTROLS, CONNECTORS AND INDICATORS



COM-120B Front Panel



00607132

COM-120B Rear Panel

(1) **Power ON Key**	Selection toggles between Power APPLIED and Power ON states.
(2) **Display**	Provides video information of current test operation.
(3) **Test Mode Keys**	GEN Test Mode Key, accesses Generate Test Mode Operation Screen. REC Test Mode Key, accesses Receive Test Mode Operation Screen. DPLX Test Mode Key, accesses Duplex Test Mode Operation Screen. SPCL Test Mode Key, accesses Optional Operation Modes.
(4) **Instruments Keys**	SCOPE Key, accesses Oscilloscope Operation Screen. ANLYZ Key, accesses Spectrum Analyzer Operation Screen. MTRS Key, accesses Independent Meters Functions. AUDIO Key, accesses Audio/Data Generators Functions.
(5) **DATA ENTRY Keys**	Numeric Keys, use to enter numeric (0-9) values. * Key, use for DTMF functions. # Key, use for DTMF functions. +/- Key, use to set sign of entered value. • Key, use to enter decimal point in numeric values. SHIFT Key, use for alphabetic function of Front Panel Keys (see table). ENTER Key, selects data field for edit or completes an editing action.

Front Panel Key/Shift Character Table

KEY	SHIFT	KEY	SHIFT	KEY	SHIFT
GEN	A	5	J	AUDIO GEN	S
REC	B	6	K	*	T
1	C	•	L	0	U
2	D	SCOPE	M	#	V
3	E	ANLYZ	N	STORE	W
+/-	F	7	O	RCL	X
DPLX	G	8	P	SHOW LIST	Y
SPCL	H	9	Q	SETUP	Z
4	I	MTRS	R	TAB	[space]

(6) CONTROL Keys

ESC Key, use to escape an editing action without change to parameters.
HOLD SCRN Key, use to freeze current screen. Press any key to return to normal operation.
START/STOP Key, use to start or stop the following operating functions:
- Reset One Shot in Oscilloscope Operation
- Bit Error Rate Meter (Option 07)
- LTR® Trunking (Option 14)

(7) ANTENNA Connector ⚠

Input connector to monitor "off-the-air" signals. Also used as a connection for low power (10 W maximum) signals.

CAUTION: DO NOT EXCEED 0.25 W MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

(8)	**SQUELCH Control**	Adjusts squelch level of received signal.
(9)	**VOLUME Control**	Controls volume of speaker.
(10)	**PHONES Connector**	Provides access for using Headphones when audio signal is present.
(11)	**SCROLL SPINNER**	Allows operator to scroll through current test mode operation screen, scroll through lists of parameter selections and actively increase and decrease one digit of numeric parameters.
(12)	**T/R Connector** ⚠	50Ω Connector for high power input or output signals. **CAUTION:** DO NOT EXCEED 200 MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.
(13)	**AUX RF OUT** ⚠	50Ω Auxiliary output connector for RF signals. **CAUTION:** DO NOT EXCEED 0.25 W MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.
(14)	**AUDIO/DATA GEN** ⚠	600Ω connector for output of audio and data generators. Access is selectable from individual generator setup screens. **CAUTION:** DO NOT EXCEED 20 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

(15) **DEMOD Connector** ⚠

600Ω connector for output of demodulated signals. Access is selectable from individual generator setup screens.

CAUTION: DO NOT EXCEED 20 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

(16) **MIC/ACC** ⚠

Provides access for microphone or accessory equipment. Both generate and receive lines are available.

CAUTION: DO NOT EXCEED 20 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

(17) **DATA SCROLL**

Allows operator to scroll though current test mode operation screen, scroll through list of parameter selections and actively increase and decrease one digit of numeric parameters.

(18) **EXT MOD** ⚠

100 kΩ connector allows input for external modulation source.

CAUTION: DO NOT EXCEED 20 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

(19) **AUDIO/DATA IN** ⚠

100 kΩ connector allows input of external audio and data signals.

CAUTION: DO NOT EXCEED 30 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.

20	**SCOPE/DVM** ⚠	1 MΩ input to Oscilloscope and Digital Voltmeter. **CAUTION:** DO NOT EXCEED 200 V MAXIMUM CONTINUOUS INPUT OR DAMAGE TO THE COM-120B MAY RESULT.
21	**MEMORY Keys**	STORE Key, selection allows operator to store current Operation Screen and all current parameters for future. RECALL Key, selection allows operator to recall previously stored Operation Screens. SHOW LIST Key, provides access to menu of all storage lists. SETUP Key, provides access to setup menu for system information and system configuration.
22	**PCMCIA Card Slot**	Provides access to enhance software capability.
23	**Soft Function Keys**	Provides access to defined function.
24	**Power ON LED**	Denotes unit is ON when lit.
25	**Power APPLIED**	Denotes power is provided to the unit when lit.
26	**DC Input** ⚠	Accepts dc power cord to supply dc power (12 to 30 Vdc) to COM-120B. **CAUTION:** DO NOT EXCEED 12 TO 30 Vdc OR DAMAGE TO THE COM-120B MAY RESULT.
27	**DC Fuse** ⚠	10 A, 32V Slo-Blo Fuse is provided for dc operation.

CAUTION: ONLY USE A 10 A, 32V SLO BLO FUSE OR DAMAGE TO THE COM-120B MAY RESULT.

(28) **AC Input** ⚠	Accepts ac power cord to supply ac power (90 to 265 VAC) to COM-120B.

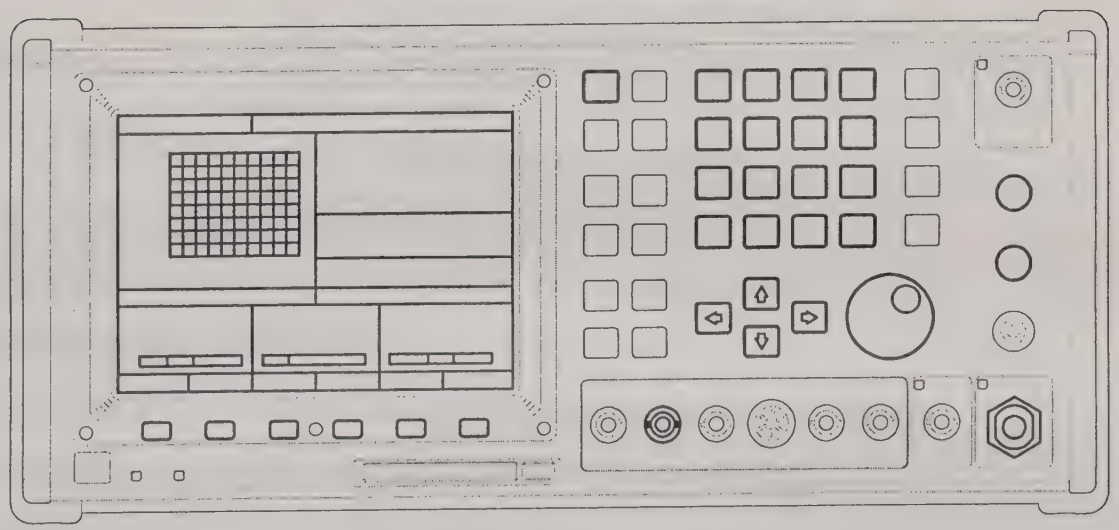
CAUTION: DO NOT EXCEED 90 TO 265 VAC OR DAMAGE TO THE COM-120B MAY RESULT.

(29) **AC Fuse** ⚠	Two 2 A fuses are provided for ac operation.

CAUTION: ONLY USE A 2 A FUSE OR DAMAGE TO THE COM-120B MAY RESULT.

(30) **Main Power Switch**	Switches power applied ON and OFF.
(31) **Battery Access Panel**	Provides access to battery.
(32) **RS-232 Connector**	Provides serial interface for remote operations with COM-120B.
(33) **GPIB Connector**	IEEE-488 connector provides parallel interface for remote operation with COM-120B.
(34) **Reference Connector**	Provides connection for input of external 10 MHz Reference Signal.

RECEIVER TESTING



00607138

Controls, Connectors and Indicators shown here in **bold** are used during Receiver Testing.

MEASURING RECEIVER CENTER FREQUENCY, et al

This procedure configures the COM-120B RF Generate Operation Screen to measure Receiver Center Frequency, Modulation Acceptance Bandwidth and 12 dB SINAD Sensitivity (Receiver Sensitivity).

Why are these measurements important?

The *Receiver Center Frequency* test determines if the local oscillators are close to the design frequency and if the IF is aligned properly. Measurement of *Modulation Acceptance Bandwidth,* while set up to do the normal *12 dB SINAD Sensitivity* test, quickly determines the radio's overall low level signal performance.

The Receiver Center Frequency, Modulation Acceptance Bandwidth and 12 dB SINAD Sensitivity all contribute to a receiver's performance at low signal levels.

RECEIVER CENTER FREQUENCY

The receiver center frequency is the frequency that produces the best SINAD reading.

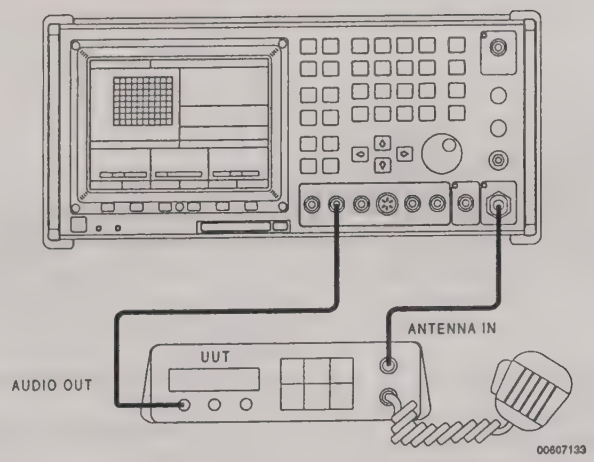
MODULATION ACCEPTANCE BANDWIDTH

Modulation acceptance bandwidth is measured by increasing the deviation until distortion occurs in the 1 kHz tone due to bandwidth limitations.

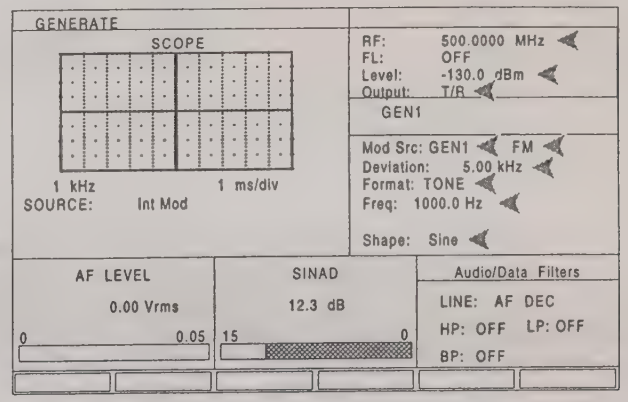
12 dB SINAD SENSITIVITY

SINAD is the acronym for **S**ignal + **N**oise **A**nd **D**istortion. SINAD is the voltage ratio of signal, noise and distortion to noise and distortion and is expressed in dB. 12 dB is the most common SINAD specification point. SINAD is a more accurate method of measuring the readability of a signal because distortion is measured in the 1 kHz signal in addition to quieting. A badly distorted audio signal fails a SINAD test.

TEST SETUP



RECEIVER CENTER FREQUENCY



Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) ANTENNA IN via a coaxial cable.

Connect the UUT AUDIO OUT to the COM-120B AUDIO/DATA/SINAD IN via a coaxial cable.

RF GEN AUDIO / DATA FILTERS SETUP MENU				
LINE	BAND PASS FILTER	HIGH PASS FILTER	LOW PASS FILTER	WIDE - BAND
DTMF / SINAD	OFF	300 Hz	4 kHz	ON
*** PRESS 'EXEC' TO ACTIVATE SELECTION ***				
SPEAKER / PHONES	INT - MOD			

00607135

To start, cursor to the Audio/Data Filter LINE field. Press F1 [AF DEC].

Press F6 [CONFIG]. Make the appropriate edits to the RF Gen Audio/Data Filters Setup Menu.

Don't forget to press F5 [EXEC] to activate the selection.

F6 [RETURN] exits to the previous screen.

Cursoring to the Level field gains access to F5 [SINAD=] and F6 [S=ON/OFF].

Set F5 [SINAD=] to 12 dB.

Press F6 [S=ON/OFF] and the COM-120B goes to work in pursuit of the 12 dB target. Deactivate the SINAD search function when 12 dB is reached on the SINAD Meter.

Adjust the RF field for the highest SINAD Meter reading to reveal the actual *UUT* Center Frequency.

12 dB SINAD SENSITIVITY

Measure Receiver Center Frequency first to ensure accurate test results.

Cursor to the Level field and press F5 [SINAD=].

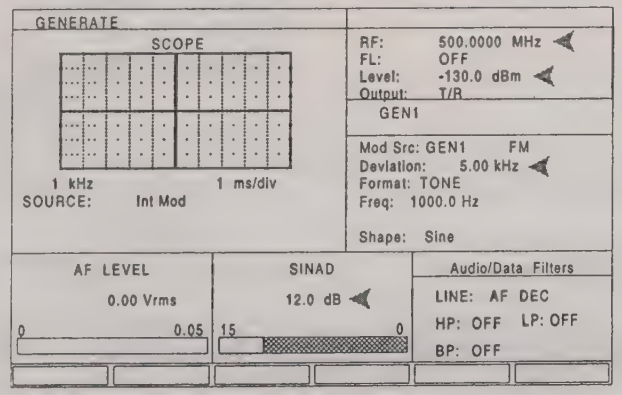
Set the SINAD= field to 10 dB or 12 dB (as specified by the Receiver Manufacturer) and press F6 [RETURN].

Press F6 [S=ON/OFF] to activate the SINAD search function.

Press F6 [S=ON/OFF] to deactivate the SINAD search function *after* the Level settles.

This Level is the Receiver Sensitivity Level.

MODULATION ACCEPTANCE BANDWIDTH



00607139

Measure Receiver Center Frequency first to ensure accurate test results.

Cursor to the Level field and press F5 [SINAD=].

Set [SINAD=] to 12 dB and press F6 [RETURN].

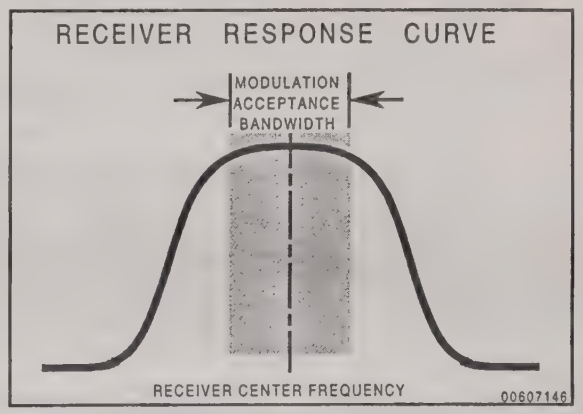
Press F6 [S=ON/OFF] to activate the SINAD search function.

Press F6 [S=ON/OFF] to deactivate the SINAD search function *after* the Level settles.

Now, increase the COM-120B Level 6 dB.

Then, increase the COM-120B Deviation Level until the SINAD Meter reads 12 dB.

Now, mathematically double the Deviation Level to discover the Modulation Acceptance Bandwidth.



NOTES

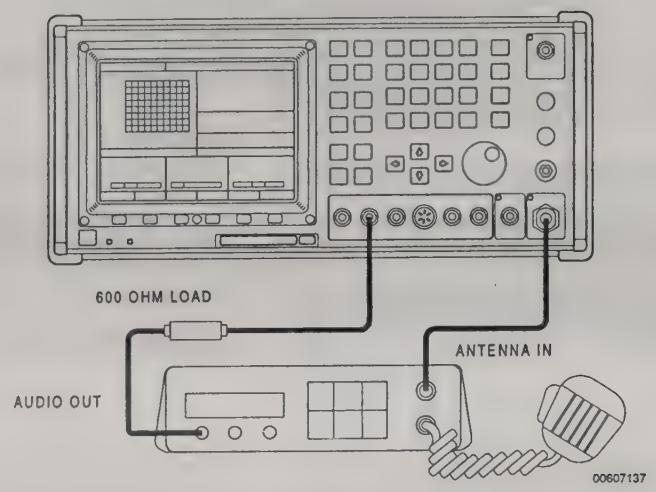
MEASURING RECEIVER AUDIO OUTPUT LEVEL

This procedure configures the RF Generate Operation Screen to measure Receiver Audio Output Level.

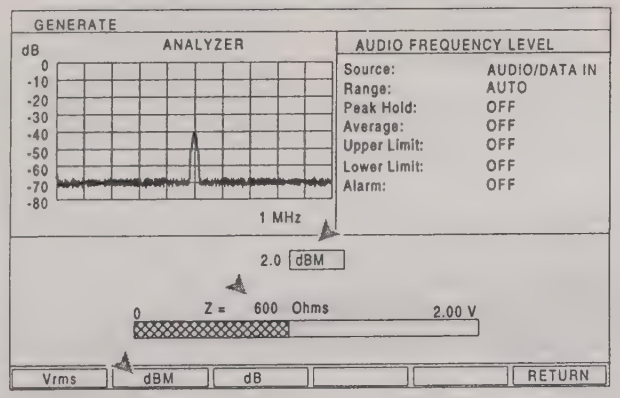
Why measure the receiver audio output level?

The audio output level of a receiver is dependent on internal audio amplifier circuitry. The inherent audio amplifier circuitry increases the energy level of the audio frequency output signal which must have enough drive to effectively reproduce the original input. This test provides a visual representation of the audio output level. What goes in, must come out!

TEST SETUP



AUDIO FREQUENCY LEVEL SCREEN SETUP



00607136

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) ANTENNA IN via a coaxial cable.

Measure Receiver Center Frequency first to ensure accurate test results.

Cursor to Audio/Data Filters Line field and press F6 [CONFIG].

Set High Pass and Low Pass Filters to OFF. Don't forget to press F5 [EXEC] to activate the selection.

F6 [RETURN] exits to the previous screen.

Now, adjust the UUT Audio Output for the desired output.

Cursor to the AF LEVEL field and press F1 [ZOOM].

Press F2 [dBm] to reveal impedance for dBm reading.

The COM-120B uses a standard 600 Ohms default. The Z = field is editable from 0 to 1000 Ohms.

Attach an external load between the *UUT* Audio Output and the COM-120B AUDIO/DATA/SINAD IN input.

The illustration uses a 600 Ohm load.

The Audio Frequency Level Meter reading that results is the Audio Output Level of the *UUT*.

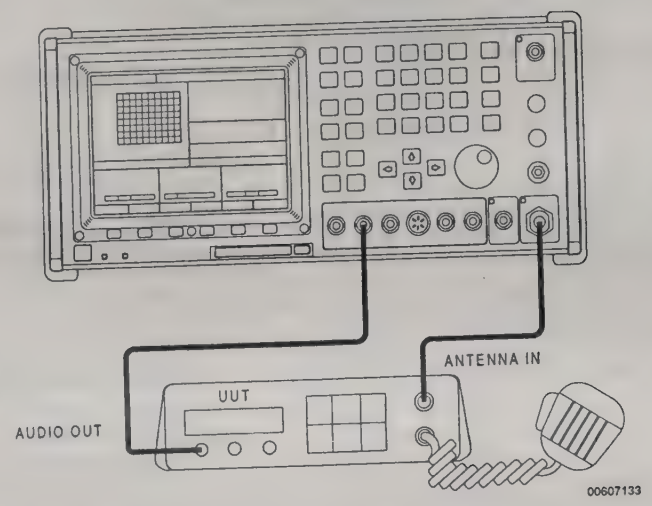
MEASURING RECEIVER IF BANDWIDTH

This procedure configures the RF Generate Operation Screen to measure Receiver IF Bandwidth.

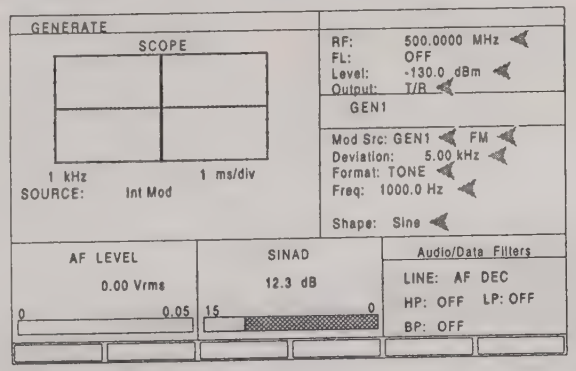
Why check the receiver IF Bandwidth?

The IF filtering network determines the receiver's selectivity. If too narrow, audio distortion is produced. If too wide, there may be adjacent channel interference. Symmetry of the IF filter is important for recovering audio with the lowest distortion.

TEST SETUP



IF BANDWIDTH SCREENS SETUP



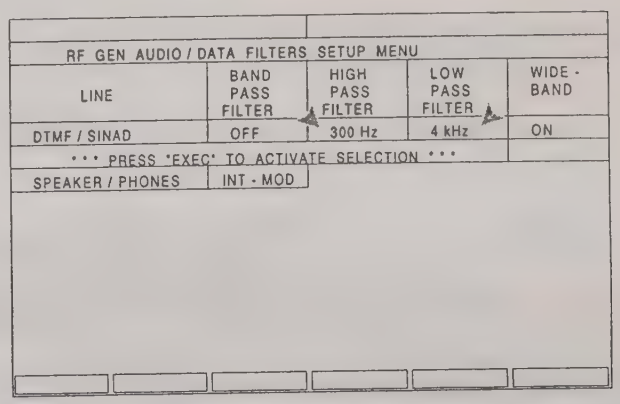
00607134

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) ANTENNA IN via a coaxial cable.

Measure Receiver Center Frequency first to ensure accurate test results.

Set the UUT Receiver Squelch to the lowest setting without breaking squelch.



00607135

To gain access to the RF Gen Audio/Data Filters Setup Menu, press F6 [CONFIG] after setting the Audio/Data Filter Line field to ***AF DEC.*** Make the appropriate edits.

Don't forget to press F5 [EXEC] to activate the selection.

F6 [RETURN] exits to the previous screen.

Cursoring to the Level field gains access to F5 [SINAD=] and F6 [S=ON/OFF].

Set the SINAD target reading at 12 dB.

Activate the SINAD search function and the COM-120B goes to work in pursuit of the 12 dB target.

Press F6 [S=ON/OFF] to deactivate the SINAD search function when 12 dB is reached on the SINAD Meter.

This Level is the Reference Sensitivity.

Increase this COM-120B Level 60 dB.

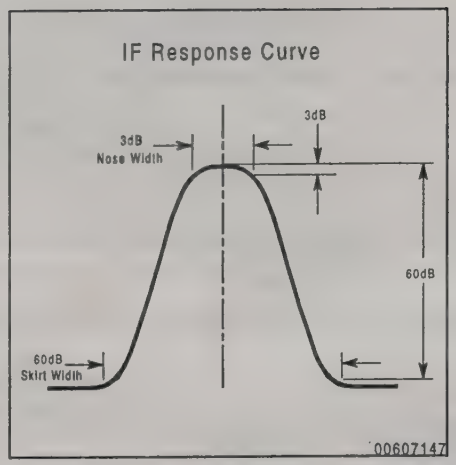
Now, increase the COM-120B RF field until the SINAD Meter reads 12 dB.

Note the resulting frequency as the Upper Frequency.

Now, decrease the COM-120B RF field past the UUT Center Frequency until the SINAD Meter reads 12 dB.

Note the resulting frequency as the Lower Frequency.

Mathematically, subtract the Lower Frequency from the Upper Frequency to obtain the Receiver IF Bandwidth.



NOTES

MONITORING PAGING RECEIVERS

This procedure configures the RF Generate Operation Screen to monitor Paging Receivers.

Why test pagers?

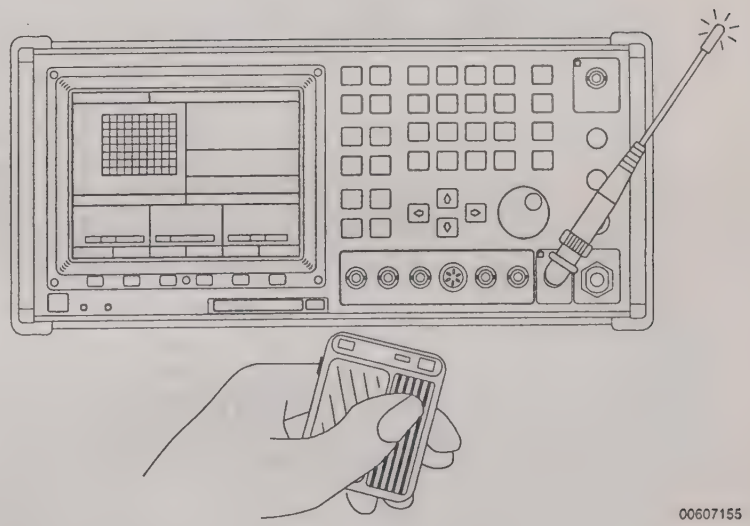
Propagation, fading, shading and off-frequency conditions are some of the things that affect a paging system.

Individual pagers react differently to variations in signal level, modulation and frequency. The objective is to determine pager reaction.

The key to successful pager testing requires the simulation of real-world conditions that affect pager operation.

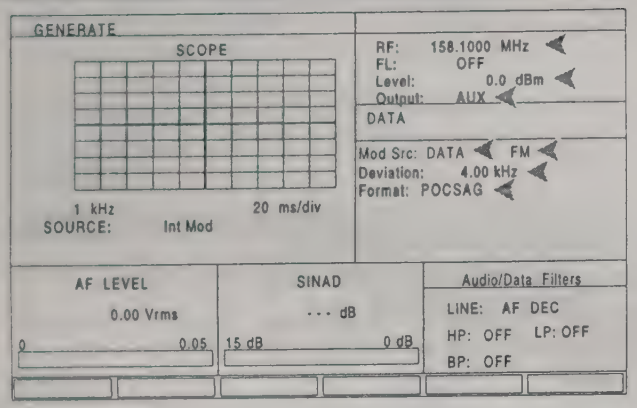
"Flaky" pagers are a source of frustration and may cause a loss of revenue and customers.

TEST SETUP



00607155

GENERATE OPERATION SCREEN



00607159

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect an antenna to the COM-120B AUX RF OUT connector.

To start, press Mode Hardkey [GEN].

The following settings are intended as an example. Actual settings for this test may vary depending on the paging transmitter.

Cursor to these fields and set the:

RF field to ***Pager Assigned Center Frequency.***
Output field to ***AUX.***
Level field to ***0.0 dB.***
Mod Src field to ***DATA*** and ***FM.***
Deviation field to ***4.00 kHz.***

Now, cursor to the Format field and press F1 [MENU].
Select POCSAG and press F6 [RETURN].

Menu selections depend on installed options.

Press F6 [CONFIG].

Set the appropriate DATA RATE, CAPCODE RANGE and FUNCTION for the pager under test.

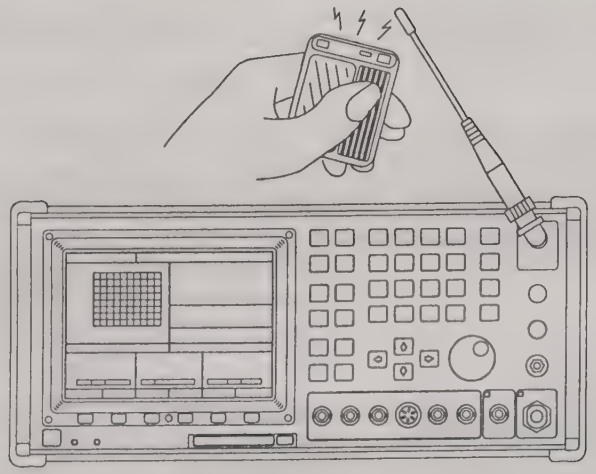
Press F6 [RETURN].

Power ON the pager under test to an idle state.

Press F5 [BURST] to simulate a page.

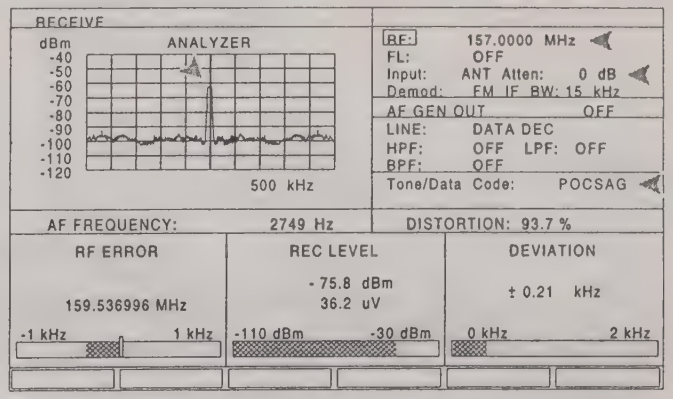
If the pager fails to respond, there is a problem. Review the field settings. Observe the burst transmission on the COM-120B scope or analyzer display. If these are satisfactory, the pager is the problem.

TEST SETUP



00607156

RECEIVE OPERATION SCREEN



00607160

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect an antenna to the COM-120B Antenna connector.

To start, press Mode Hardkey [REC].

The following settings are intended as an example. Actual settings for this test may vary depending on the paging transmitter.

Cursor to these fields and set the:

RF field to ***Pager 1st IF Frequency***.
Input field to ***ANT***.
Atten field to ***0 dB***.

Now, cursor to the Tone/Data Code field and press F1 [MENU]. Select a format and press F6 [RETURN].

Usable selections depend on installed options.

Power ON the pager under test to an idle state.

Position the pager close to the antenna to allow the COM-120B to "sniff" the Pager's 1st LO frequency.

Observe the sniffed LO frequency on the analyzer display.

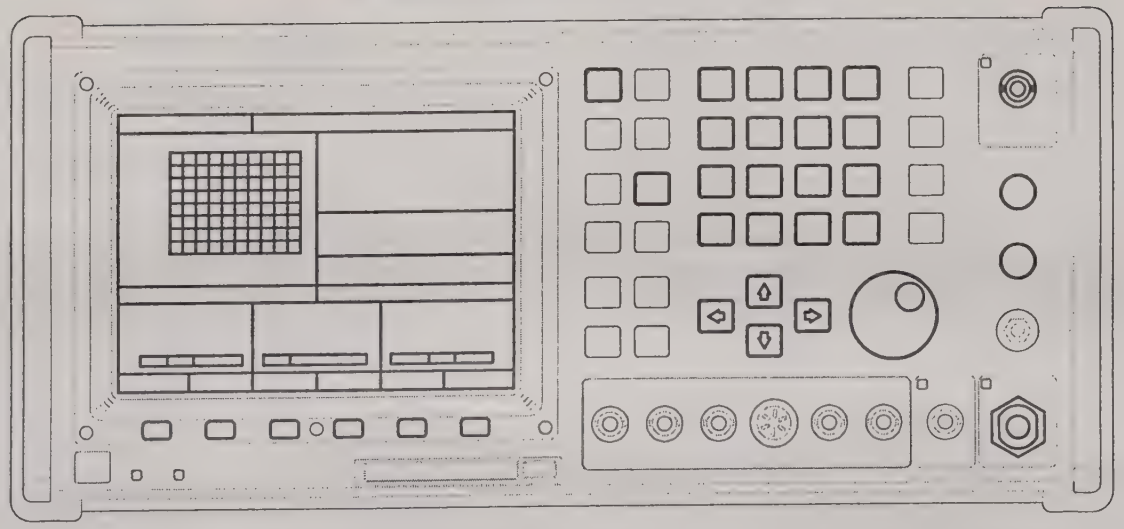
Adjust the Pager LO frequency to the analyzer center graticule.

Absence of a Pager signal may indicate the Pager's 1st LO isn't running.

Reference the COM-120B RF ERROR Meter. Pager Frequency may be in error.

NOTES

TRANSMITTER TESTING



00607140

Connectors, Controls and Indicators shown here in **bold** are used during Transmitter Testing.

MEASURING TRANSMITTER HARMONICS

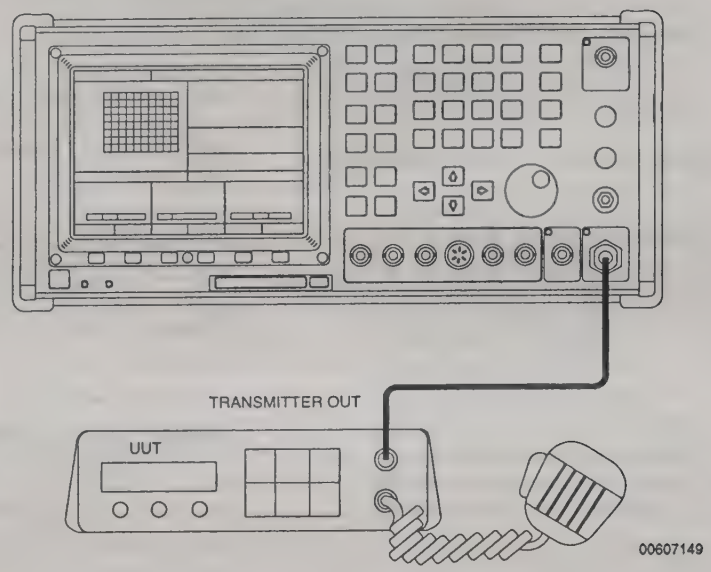
This procedure configures the Analyzer Operation Screen to measure Transmitter Harmonics.

Is transmitter harmonics a major concern?

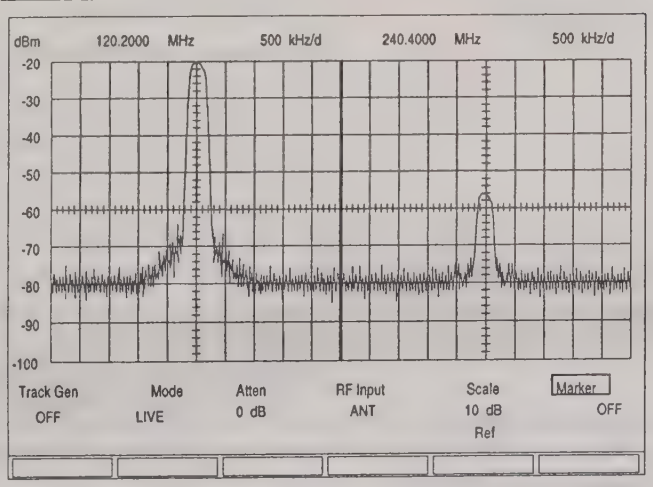
Yes. The F.C.C. harmonic specification requires that all emissions beyond a certain percentage of the authorized bandwidth be attenuated. Check F.C.C. Regulations for proper harmonic specifications.

Minimum attenuation for signals ≥250% of authorized bandwidth. (harmonics & spurious)			
Xmtr power in watts	Min. atten. dB below cw	Xmtr power in watts	Min. atten. dB below cw
1	43	100	63
5	50	150	65
10	53	200	66
25	57	250	67
50	60	300	68
75	62	500	70

TEST SETUP



ANALYZER SCREEN SETUP



00607141

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) TRANSMIT OUT via a coaxial cable.

Measure Receiver Center Frequency first to ensure accurate test results.

First, press Instruments Hardkey [ANLYZ].

Cursor to the Logarithmic Function field above the vertical scale and set to ***dBm***.

Cursor clockwise and set the Scan Width field to ***500 kHz***. Cursor to these fields and set the:

- Sweep field to ***5 ms/div.***
- Analyzer Center Frequency field to ***UUT Transmitter Frequency.***
- Resolution Bandwidth field to ***300 kHz.***
- Track Gen field to ***OFF.***
- Mode field to ***LIVE.***
- Atten field to ***0 dB.***
- RF Input field to ***T/R.***
- Scale field to ***10 dB.***
- Marker field to ***OFF.***
- Ref field to ***-20 dBm at top of the vertical scale.***

Now, make the following connections

Connect *UUT* Transmitter output to COM-120B T/R connector.

Key the transmitter to view the *UUT Transmitter Frequency* signal.

Adjust the transmitter fundamental signal level as near the top graticule as possible *without* exceeding the graticule to obtain the maximum dynamic range.

Cursor to the Marker field and press F1 [ON/OFF].

Match the Marker frequency to the Analyzer Center Frequency.

Note the Marker Level. Call this reading F_1.

Cursor to Analyzer Center Frequency field and double the frequency to view the first harmonic.

Note the Marker Level. Call this reading F_2.

$F_1 - F_2$ = first harmonic dBc

Triple the Analyzer Center Frequency to view the second harmonic.

Note the Marker Level. Call this reading F_3.

$F_1 - F_3$ = second harmonic dBc

Press F4 [Split] to view any pair of harmonic frequencies simultaneously. Independently adjust each analyzer screen frequency.

Marker remains OFF in split screen mode.

NOTES

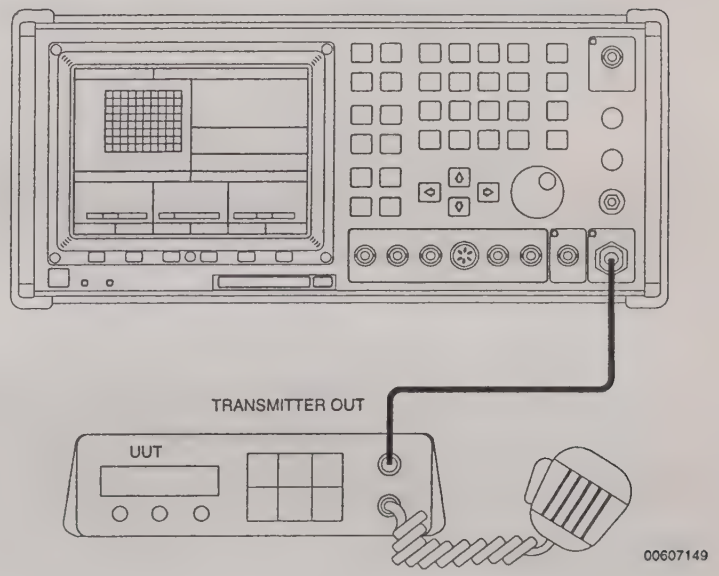
MEASURING TRANSMITTER FREQUENCY ERROR

This procedure configures the RF Receive Operation Screen to measure the Frequency Error of a 100 MHz RF Signal at the T/R connector.

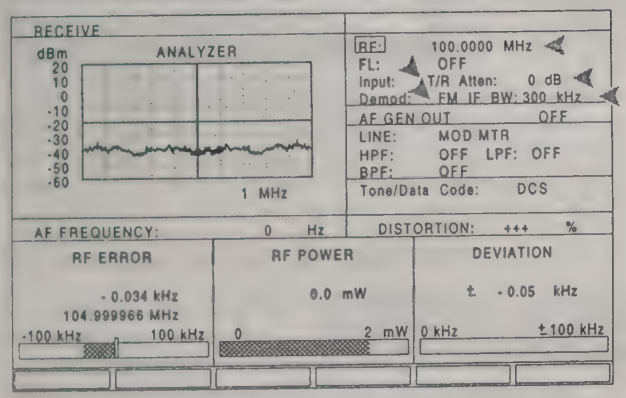
Why measure transmitter frequency error?

If a radio was set to transmit on a particular frequency and a significant internal transmitter frequency error existed, the transmission might never be received.

TEST SETUP



RF FREQUENCY ERROR SCREENS



00607143

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) TRANSMIT OUT via a coaxial cable.

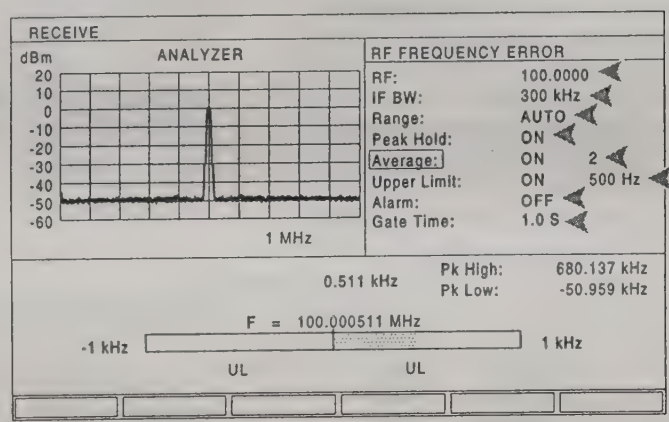
Measure Receiver Center Frequency first to ensure accurate test results.

To start, press Mode Hardkey [REC].

Cursor to these fields and set the:

RF field to ***Transmitter Center Frequency.***
Input field to ***T/R.***
Atten field to ***0 dB.***
Demod field to ***FM.***
BW field to ***300 kHz.***

Now, cursor to the RF ERROR Meter and press F1 [ZOOM].



00607142

Set the Range field to ***AUTO***.

Peak Hold remains ***OFF*** in AUTO range.

Set the Average field to ***ON*** and select the number of samples to be averaged before a reading is reported. Range is 2 to 10.

Set the Upper Limit field to ***ON*** and select an Upper Limit value. Range is 0 to 100000 Hz.

If desired, set the Alarm field to ***ON*** and an audible alarm sounds when the signal exceeds the Upper Limit.

Set the Gate Time field to ***1.0 S***.

Press F6 [RETURN].

Now, using a coaxial cable, apply the Transmitter Center Frequency Signal to the COM-120B T/R connector.

NOTES

MEASURING TRANSMITTER DISTORTION

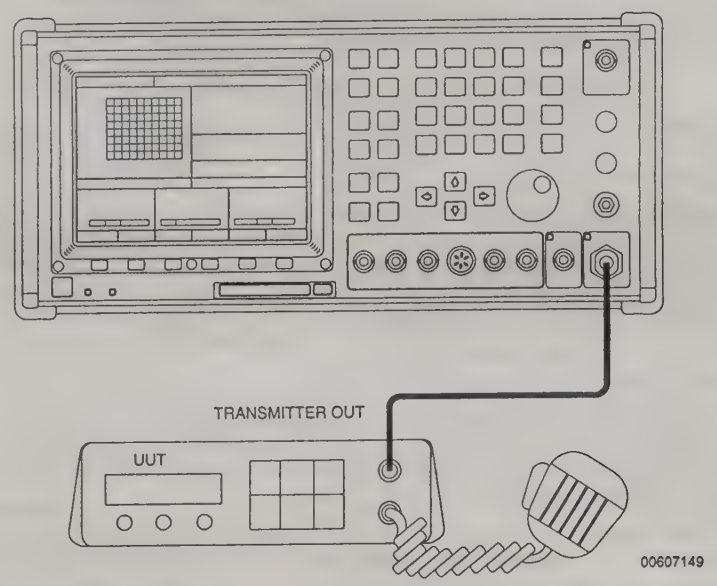
This procedure configures the RF Receive Operation Screen to measure the Distortion of a 100 MHz RF Signal at the T/R connector. The signal is FM Modulated and has a 1 kHz sine wave as audio.

Why measure transmitter distortion?

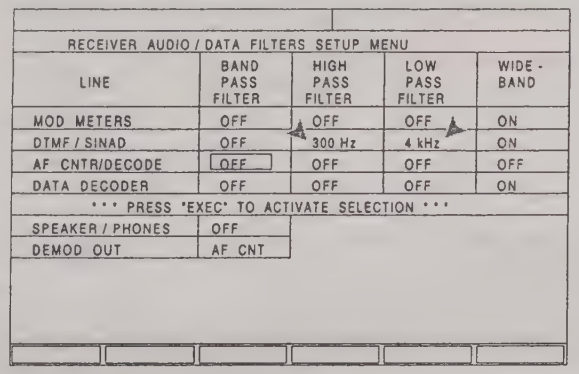
The audio stages of a transmitter produce measurable distortion. Also, a phase modulator that is improperly adjusted can produce distortion which is detectable using this measurement.

If the transmitter uses a phase modulator, tune the phase modulator stage for minimum distortion. A compromise may be necessary between the best distortion and deviation level.

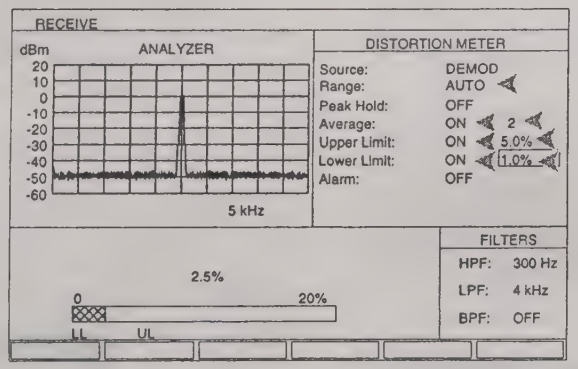
TEST SETUP



AUDIO FREQUENCY SCREENS



00607150



00607151

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R RF IN/OUT to the Unit Under Test (UUT) TRANSMIT OUT via a coaxial cable.

Measure Receiver Center Frequency first to ensure accurate test results.

To start, press Mode Hardkey [REC].

Cursor to these fields and set the:

RF field to ***Transmitter Center Frequency.***
Input field to ***T/R.***
Atten field to ***0 dB.***
Demod field to ***FM.***
BW field to ***300 kHz.***

Now, cursor to the LINE field and press F1 [MENU]. Select DTMF/SINAD and press F6 [RETURN].

To gain access to the Receiver Audio/Data Filters Setup Menu, press F6 [CONFIG].

Cursor to DTMF/SINAD and set the High Pass Filter to 300 Hz and Low Pass Filter to 4 kHz.

Don't forget to press F5 [EXEC] to activate the selection.

F6 [RETURN] exits to the previous screen.

OK, cursor to the DISTORTION Meter and press F1 [ZOOM].

Cursor to these fields and set the...

Range field to ***AUTO***. Peak Hold remains OFF in AUTO range.
Average field to ***ON*** and select the number of samples to be averaged before a reading is reported. Range is 2 to 10.
Upper Limit field to ***ON*** and select an Upper Limit value. Range is 0.0% to 100%.
Lower Limit field to ***ON*** and select a Lower Limit value. Range is 0.0% to 100%.
Alarm field to ***ON*** if desired. An audible alarm sounds when the signal exceeds the Upper Limit.

Press F6 [RETURN].

The COM-120B is capable of generating a 1 kHz signal to modulate the transmitter carrier signal.

Set the AF GEN OUT field to ON. Press F1 [ZOOM].

Cursor to these fields and set the:

Source field to ***GEN2.***
State field to ***ON***
Freq field to ***1000.0 kHz.***
Shape field to ***SINE.***
Level field to ***1 V.***

Press F6 [RETURN].

Now, using a coaxial cable, apply the Transmitter Center Frequency signal to the COM-120B T/R connector.

Key the transmitter and hold the mic over the COM-120B speaker vent located on the left side of the case near the back.

Rotate the COM-120B Volume Control Knob clockwise and note the meter readings.

For a more accurate reading, connect the COM-120B AUDIO/DATA GEN OUT to the radio mic. Set the Level to the lowest value that provides adequate deviation. Some radios may require a 10 dB pad to lower the audio level.

NOTES

ANALYZING INTERMOD DISTORTION

This procedure configures the RF Receive Operation Screen to analyze Intermod Distortion.

When intermodulation problems occur, first determine if the problems are generated within the receiver by mixing products or are produced by mixing in an external non-linear device such as corroded antenna connections or in a nearby transmitter.

Externally or Internally produced?

Eliminate the receiver first by splitting the signal from the antenna and feeding both the receiver in question and the COM-120B's receiver. Listen to the receiver for the intermod and look on the analyzer display at the receive frequency. If noise is heard from the receiver and not seen on the analyzer, this *only* determines that *on channel* intermod is not produced externally. A mixing product generated externally and interfering on a spurious response frequency within the receiver or a mix within the receiver may be the problem.

To determine if the mix is within the receiver:

Lightly couple the receiver's 1st IF output into the COM-120B antenna connector with a *sniffer loop**. Tape the sniffer loop down so that the sniffed signal remains constant. When the interfering signal is heard, set the top of the signal to the top of the screen.

Install a 3 dB attenuator in the outside antenna line. If the analyzer signal level drops *appreciably* more than 3 dB, the intermod is produced within the receiver. If the drop is only 3 dB, the source is external, probably in a nearby transmitter or antenna system.

To determine if the mix is within the suspected transmitter:

A tuned isolator is needed in the suspected transmitter's output line to provide different forward and reverse loss factors.

Measure the forward and reverse loss at the intermod frequency.

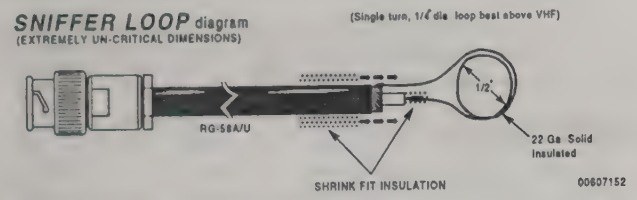
Connect the RF Coupler's output to the COM-120B Antenna input.

Adjust the coupler to establish an intermod reference level the intermod appears again.

Install isolator and note the attenuation in the intermod.

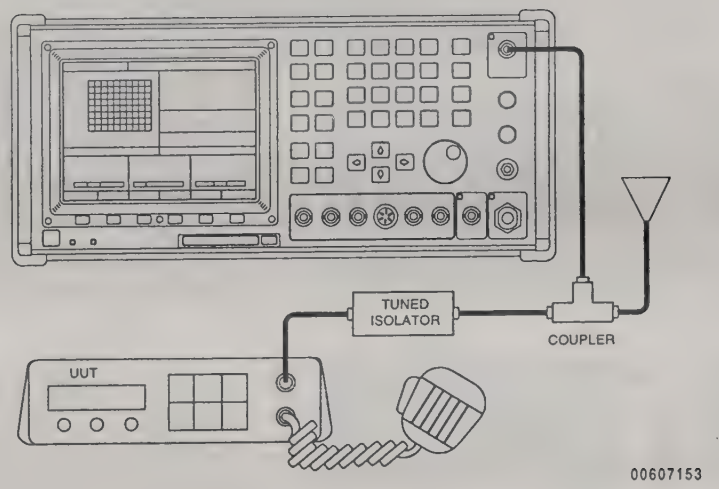
If the intermod signal drops by the forward attenuation of the isolator, the intermod is not being caused by this transmitter.

If the intermod signal drops by the reverse attenuation of the isolator, this is the offender.



***SNIFFER LOOP** is nothing more than one or two turns of insulated wire on one end of a convenient length of coaxial cable. Install a male BNC connector on the other end to connect to the COM-120B Antenna Input.

TEST SETUP



ISOLATION AND INSERTION LOSS

This procedure configures the RF Receive Operation Screen to measure Isolation and Insertion Loss.

T-R relays can be a source of several problems. Low transmitter power, poor receiver sensitivity and even intermod interference problems.

Transmitter Power Loss

Transmit Power loss caused by the relay is easily isolated by measuring output power with and without the relay.

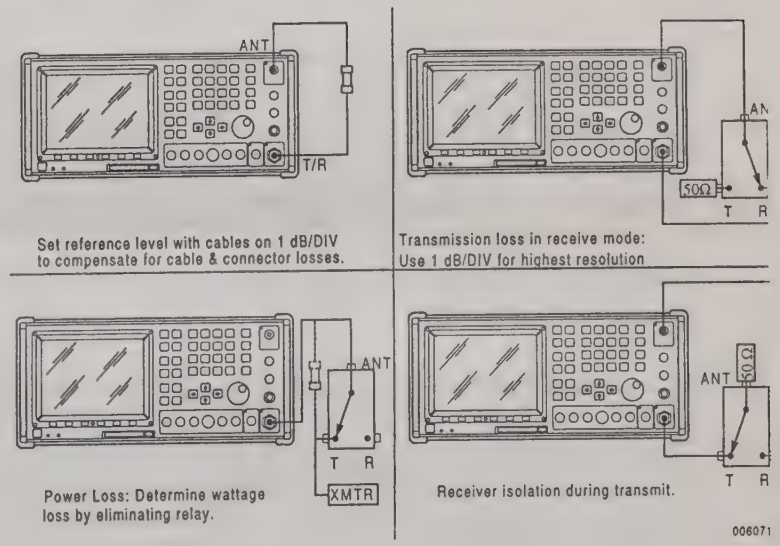
Receiver Sensitivity Loss

Receiver sensitivity loss is isolated by measuring the transmission loss at the receiver frequency. Sensitivity loss is more likely to be an intermittent problem due to the lack of power to punch through the thin corrosion layer on the receive contacts.

T-R Relay May Be An Intermod Source

Corrosion on contacts may act as a diode, creating an unwanted mixer when excited by strong RF signals from the antenna.

TEST SETUP



MONITORING DCS & CTCSS

This procedure configures the RF Receive Operation Screen to monitor DCS and CTCSS.

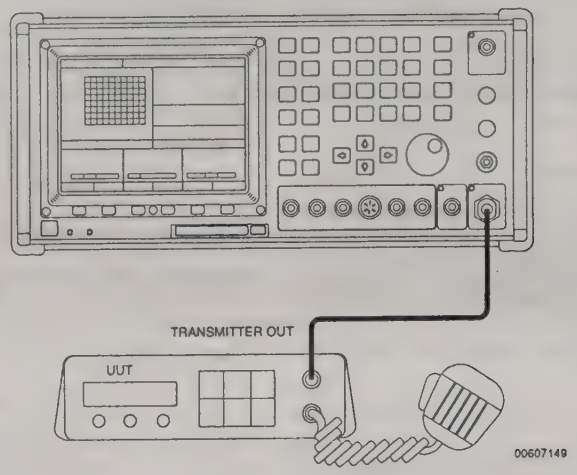
What Is DCS?

DCS, or **D**igitally **C**oded **S**quelch, uses subaudible frequencies and a 23-bit digital "word" to mute radio receiver background noise and unwanted communications. The DCS 83 codeword capacity may all be used on the same channel. The codeword is repeated cyclically every 171 ms and ends with a 180 ms burst of turn-off code-a 134 Hz tone. The DCS codeword's 1s and 0s are converted into an analog signal to continuously modulate the FM carrier.

What Is CTCSS?

CTCSS, or **C**ontinuous-**T**one **C**oded **S**quelch, uses subaudible frequencies below 300 Hz. One tone is assigned to a user. The decoding device in the radio switches on the speaker when the proper tone is received. Tones are below the 300 Hz to 3000 Hz audio speech band. A low-level subaudible tone is superimposed continuously with the voice on the FM carrier.

TEST SETUP



Connect the COM-120B T/R connector to the Unit Under Test (UUT) TRANSMIT OUT via a coaxial cable.

Option: Connect antenna to COM-120B ANT connector to sniff off the air.

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

DCS or CTCSS GENERATE.

To start, press Mode Hardkey [REC].

Cursor to these fields and set the:

Scope/Analyzer field to ***Scope.***
RF field to ***Transmitter Center Frequency.***
Input field to ***T/R.***
Atten field to ***0 dB.***
Demod field to ***FM.***
IF BW field ***as appropriate.***

If using FM, cursor to the Deviation Meter and perform an FM-Zero.

Key the transmitter to verify the COM-120B receives the signal.

DCS Generate.

Cursor to the LINE field. Press F1 [MENU].

Press F6 [CONFIG]. Set the DATA DECODER Low Pass Filter to ***300 Hz.*** Press F5 [EXEC]. Press F6 [RETURN].

Cursor to these scope fields and set the:

SOURCE field to ***Data Decoder.***
Vertical Scale to ***1 kHz.***
Sweep to ***20 ms/div.***

Cursor to the Tone/Data field. Press F1 [MENU].

Select DCS or DCS INV. Press F6 [RETURN].

Key the transmitter. Verify the proper DCS value is displayed.

Examine waveform on scope. It should appear like a slightly rounded square wave.

CTCSS Generate.

Cursor to the LINE field. Press F1 [MENU].

Select AF CNTR. Press F6 [RETURN].

Press F6 [CONFIG]. Set the AF CNTR/DECODE Low Pass Filter to ***300 Hz.*** Press F5 [EXEC]. Press F6 [RETURN].

Cursor to these scope fields and set the:

SOURCE field to ***AF Cntr.***
Vertical Scale to ***0.40 kHz.***
Sweep to ***20 ms/div.***

Key the transmitter. Verify the proper CTCSS frequency value is displayed on the AF Frequency field. If not...

Examine waveform on the scope. There should be a sine wave.

DCS or CTCSS RECEIVE.

Option: Connect antenna to COM-120B AUX connector to transmit over the air.

To start, press Mode Hardkey [GEN].

Cursor to these fields and set the:

RF field to ***Radio Center Frequency.***
Level field to ***-60 dBm.***
Output field to ***T/R.***

Off the Air Option:
RF field to ***Radio Center Frequency.***
Level field to ***-13 dBm.***
Output field to ***AUX.***

DCS Receive.

Cursor to these fields and set the...

Mod Src field to ***DATA.***
Select AM/FM/PM ***as appropriate for the radio.*** AM Modulation to ***20.0%***, or FM/PM Deviation to ***0.50 kHz.***
Format field to ***DCS*** or ***DCS INV.***

Verify radio unsquelches, then...

Turn DATA generator off.

Verify radio squelches.

CTCSS Receive.

Cursor to these fields and set the:

Mod Src field to ***GEN1.***
Select AM/FM/PM ***as appropriate for the radio***
AM Modulation to ***20.0%***, or FM/PM Deviation to ***0.50 kHz.***
Format field to ***Tone.***
Freq field to ***CTCSS frequency for the radio.***

Verify radio unsquelches, then...

Turn GEN1 off.

Verify radio squelches.

NOTES

HOW TO FIND AN UNKNOWN TRANSMITTER FREQUENCY

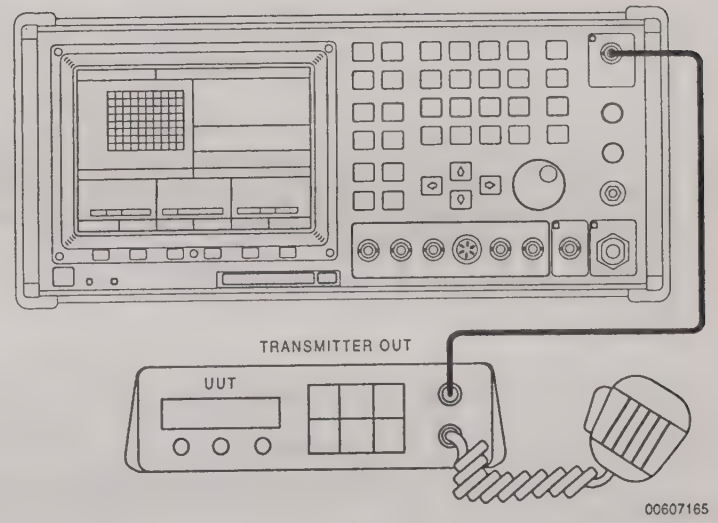
This Section is especially helpful when a radio transmit frequency is unknown. The COM-120B has an internal function that eliminates the mystery.

How does it work?

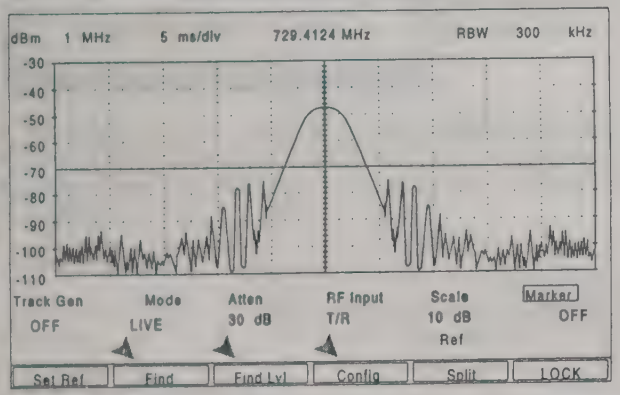
A radio needs testing, but, the transmit frequency is unknown. What to do? The COM-120B has a solution.

A general idea of the transmitter frequency is helpful, but not necessary.

TEST SETUP



ANALYZER SCREEN SETUP



00607166

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Connect the COM-120B T/R connector to the Unit Under Test (UUT) TRANSMIT OUT via a coaxial cable.

This example configures the COM-120B to locate and display an unknown transmitter frequency.

First, press Instruments Hardkey [ANLYZ].

Set the COM-120B Analyzer Center Frequency to ***500.0000 MHz***.

Set the Atten field to ***30 dB***.

Set the RF Input field to ***T/R***.

Press F4 [Config] and set the sweep width to ***500.0000 MHz***. This causes the COM-120B to sweep the entire spectrum from 0 to 1000 MHz. Press F4 [Config] again.

Press F3 [Find Lvl]. Use the Data Scroll to adjust the level marker a few dB lower than the expected signal.

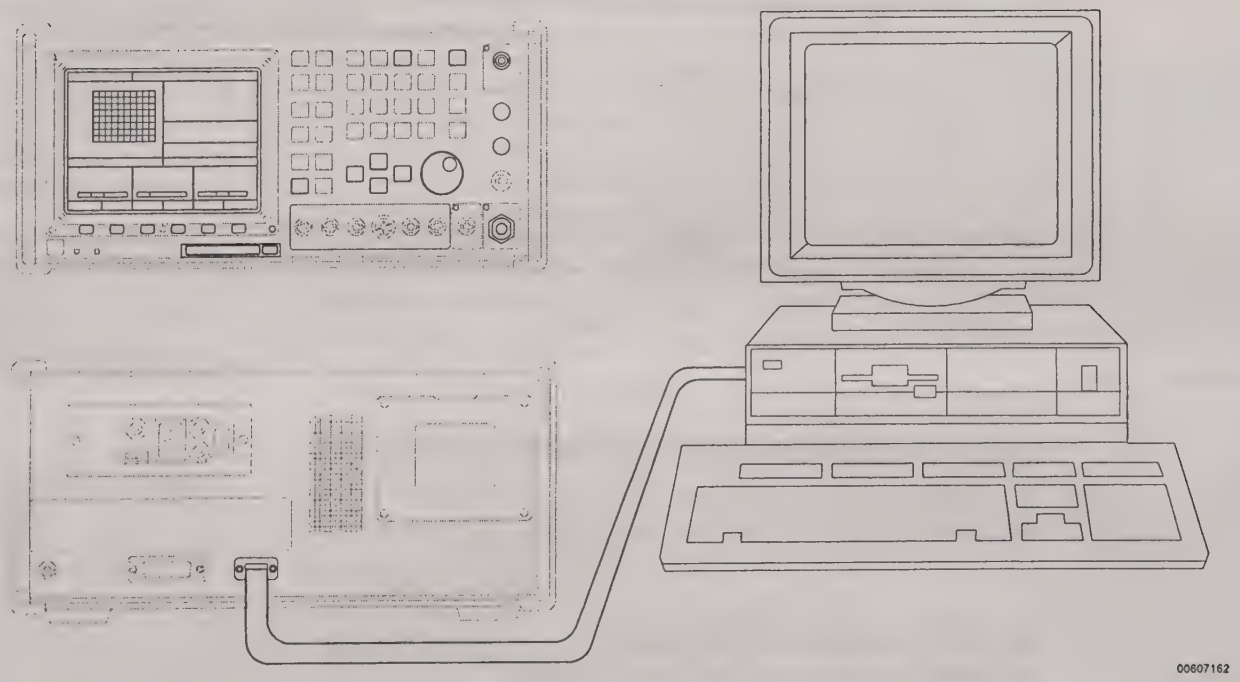
Example: For a 5 Watt signal, set the marker at 30 dB.

Press F3 [Find Lvl] again.

Press F2 [Find]. The COM-120B locates and displays the transmitter frequency signal.

NOTES

FILE SYSTEM OPERATION



Controls, Connectors and Indicators shown here in **bold** are used during File System Operation.

HOW TO CREATE A FILE

This Section is to help clear up some COM-120B File System Operation confusion. A little patience reveals the file system is really very simple to operate.

How to start.

The COM-120B Communications Service Monitor requires a direct RS-232 connection. To successfully copy or move files to the PC (Personal Computer), the COM-120B RS-232 settings must match the Baud Rate, Data Bits, Stop Bits, Parity and Handshake settings used in the RF software terminal program.

To start, press Memory Hardkey [SETUP].

[ENTER] the RS-232 SETTINGS screen.

Complete the RS-232 SETUP and press F6 [RETURN].

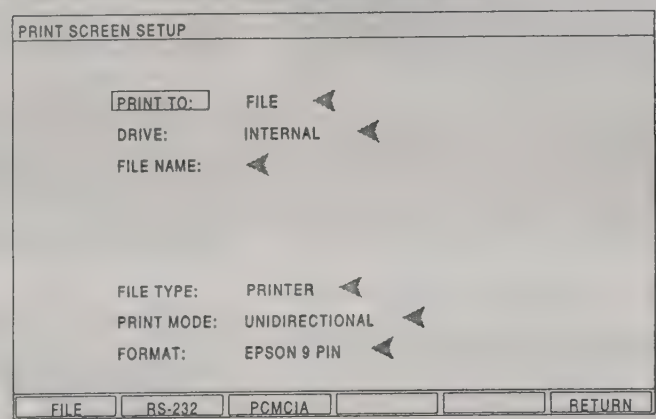
[ENTER] the PCMCIA SETUP screen.

Complete the PCMCIA SETUP and press F6 [RETURN].

The COM-120B prints to a file, printer or PCMCIA Modem or Serial Card.

The PCMCIA Card Slot is not for Memory, Flash or FAX cards! The following setup is an example.

PRINT SCREEN SETUP



00607163

To start, press Memory Hardkey [SHOW LIST].

[ENTER] the PRINT SCREEN SETUP.

Use the Data Entry Keys, Data Scroll Spinner and Data Scroll Keys to edit the appropriate fields.

Cursor to the PRINT TO field. Press F1 [FILE].

Other Options: RS-232, PCMCIA or GPIB.

Cursor to the DRIVE field. Press F1 [INTERNAL].

Other Option: EXTERNAL.

Cursor to the FILE NAME field. Press F3 [\].

Other Options: CLEAR, ...

Enter a file name. For this example, press this key sequence to create the file "SCREEN":

PRESS [SHIFT] [S AUDIO GEN] [C 1] [R MTRS] [E 3] [E 3] [N ANLYZ]

PRESS [SHIFT] [F •] [*] [ENTER]

The COM-120B automatically generates unique file names when wildcards * or ? are used. Wildcard *.* allows multiple screen captures.

Cursor to the FILE TYPE field. Press F5 [PRINTER]. The file outputs to a printer.

Other Options: BMP, PCX. These options display a COLORS field with options NORMAL, INVERT.

Cursor to the PRINT MODE field. Press F1 [UNIDIR].

Print Mode only available with File Type PRINTER selected. Other Option: BIDIR (Bidirectional).

Cursor to the FORMAT field. Press F1 [9 PIN] to format the printer output.

Other Options: 24 PIN (EPSON), HP LJ (HP LASERJET).

Select a COM-120B mode of operation.

Press Control Hardkey [HOLD SCRN] to 'freeze' the screen.

Following a short pause, special softkeys F1 [PRINT] F2 [ABORT] and F6 [RESUME] appear.

F2 [ABORT] is accessible only for a current print job. This softkey is not available once all print jobs are finished.

Press F1 [PRINT].

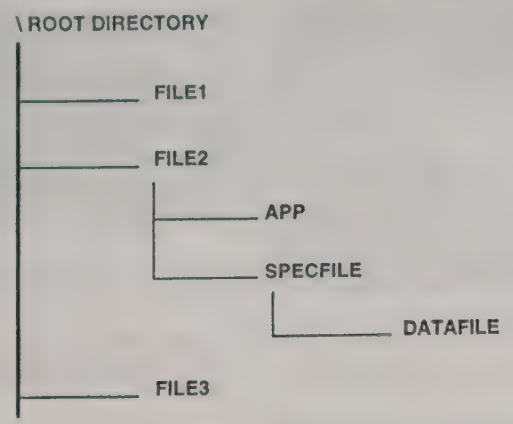
See, **FILE MANAGEMENT**.

FILE MANAGEMENT

This Section is here to provide some insight into how to manage the file system. The clue is: DOS (Disk Operated System) experience is extremely beneficial, but not necessary.

How to access and manipulate stored files.

The COM-120B Directory Structure example:



Avoid storing files in the root directory because of limited storage capacity. Use subdirectories.

To start, press Memory Hardkey [SHOW LIST].

Press F3 [FILES].

F4 [APP] appears and executes when an Application Software Option is loaded into the COM-120B.

STORED FILES SCREEN

FILE LIST 810 Kbytes free 1017 Kbytes total

[DRIVE:] INTERNAL COM120FLASH

PATH:

NAME		TYPE	SIZE	DATE	TIME	ATTR
SCREEN	.	DIR		03/16/1995	10:10:18	D
SCOPE	. TRC	TRACE	549	03/16/1995	10:10:26	A
ANALY	. TRC	TRACE	564	02/23/1996	16:17:32	A
FM_RADIO	. SET	SETUP	1443	03/16/1996	10:09:34	A
MACROS	. MAC	MACRO	393	12/20/1996	07:48:26	A
FILE1	.	DIR	693	01/12/1997	17:08:44	D
FILE2	.	DIR	458	01/18/1997	14:32:01	D
FILE3	.	DIR	1272	01/20/1997	09:15:57	D

[INTERNAL] [PCMCIA] [FIX] [ ] [PACK] [RETURN]

00607164

Notice "Kbytes free" and "Kbytes total" values located in the screen header. There is a problem if either one or both read zero. Contact IFR Systems, Inc. Customer Service Department.

To select drive where desired files are located:

Press F1 [INTERNAL] for Internal Flash Memory.

Options: FIX, repairs damage to the file system (CHKDSK operation). PACK, performs any needed packing on the file system.

Press F2 [PCMCIA] for external PCMCIA card.

Options: FIX, repairs damage to the file system (CHKDSK operation). FORMAT, an audible alarm and window warning, prompts for a confirmation. *ALL data is lost if formatted!* PACK, performs any needed packing on the file system.

Cursor to the PATH field.

Options: CLEAR, .. or \.

Enter a path (i.e., \FILE\SPECFILE) or cursor to desired subdirectory. Press F1 [OPEN].

Cursor to desired file. Press F1 [OPEN].

This action automatically runs a macro file.

How to change file Attributes.

Cursor to desired file. Press F2 [MENU]. Cursor to the FILE ATTRIBUTES field.

Press F1 [RD ONLY] to set or clear a Read Only attribute.

Press F2 [ARCHIVE] to set or clear an Archive attribute. Press F6 [RETURN].

How to Move, Copy, Delete or Rename a file.

Cursor to desired file. Press F2 [MENU]. Cursor to the ACTIONS field.

To *Move* the file, press F1 [MOVE]. Enter the *new* path and drive destination. Press F1 [MOVE].

To *Copy* the file, press F2 [COPY]. Enter the *new* path and drive destination. Press F1 [COPY].

To *Delete* the file, press F3 [DELETE]. An audible alarm and query accompany this action. *There is no recovery process for a deleted file.* Press F6 [ABORT] to quit or press F1 [DELETE].

To *Rename* the file, press F4 [RENAME]. Enter the *new* name. Press F1 [RENAME].

Simple, huh.

HOW TO RETRIEVE A FILE

This Section instructs how to download files from the COM-120B file system via a software terminal program package on the PC.

How to talk the talk.

First, make sure there is a good physical RS-232 connection between the COM-120B and PC.

re
The COM-120B Communications Service Monitor requires a direct RS-232 connection. To successfully copy or move files to the PC (Personal Computer), it is imperative the COM-120B RS-232 settings match the Baud Rate, Data Bits, Stop Bits, Parity and Handshake settings used in the RF software terminal program.

This writing assumes a PROCOMM PLUS® software terminal program package.

Configure PROCOMM PLUS®. Setup Protocol and General Options.

Make sure the terminal program package used *doesn't* look for carrier detect. Carrier detect *is not* generated by the COM-120B.

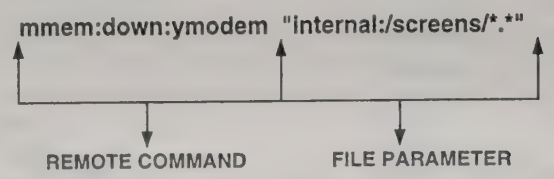
Be sure to set "Abort xfer if CD lost" to: NO

Hit [ENTER] on the keyboard. PROCOMM PLUS® returns an !. Congratulations! The COM-120B and PC are talking.

Now, type in the remote command line and file parameter.

Example:

Download the files in a directory called "screens"

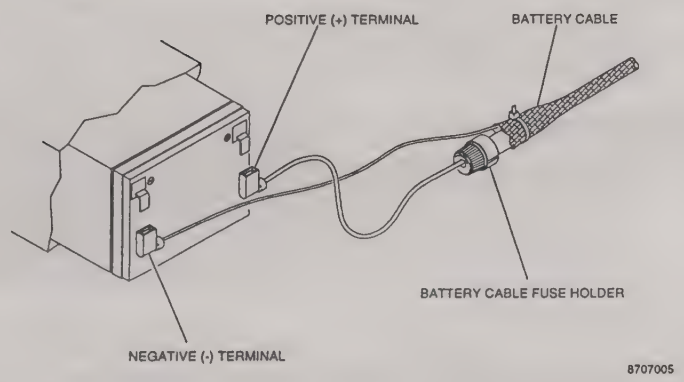


Hit [Page Down] on the keyboard to view download protocols. Hit [Y] for Ymodem (Batch).

Xmodem only retrieves one file at a time and no wildcards. The file must be specified.

The download process begins.

BATTERY FUSE REPLACEMENT



REPLACEMENT INSTRUCTIONS

1. Set COM-120B Main Power Switch to OFF.
2. Remove all power sources from COM-120B.
3. Loosen 4 Screws on Battery Access Panel and remove.
4. Disconnect Positive (+) and Negative (-) Terminals from Battery.
5. Remove Battery from cavity.
6. Pull Battery Cable out of COM-120B until Battery Fuseholder is exposed.
7. Unscrew Battery Cable Fuseholder Cap.
8. Replace Fuse with 10 A Fast-Blo Fuse.
9. Feed Battery Cable into Chassis.
10. Install Battery in cavity.
11. Connect Positive (+) and Negative (-) Terminals to Battery.
12. Install Battery Access Panel.

EXTERNAL CLEANING

The following procedure contains routine instructions for cleaning the outside of the Test Set.

CAUTION: DISCONNECT POWER FROM TEST SET TO AVOID POSSIBLE DAMAGE TO ELECTRONIC CIRCUITS.

CLEANING INSTRUCTIONS

1. Clean front panel buttons and display face with soft lint-free cloth. If dirt is difficult to remove, dampen cloth with water and a mild liquid detergent.
2. Remove grease, fungus and ground-in dirt from surfaces with soft lint-free cloth dampened (not soaked) with isopropyl alcohol.
3. Remove dust and dirt from connectors with soft-bristled brush.
4. Cover connectors, not in use, with suitable dust cover to prevent tarnishing of connector contacts.
5. Clean cables with soft lint-free cloth.
6. Paint exposed metal surface to avoid corrosion.

NOTES

SPECIFICATIONS

COM-120B PRODUCT SPECIFICATIONS

A warm-up time of 5 minutes is required for the following performance requirements.

RF measurements are referenced to 50 Ω.

Accuracy and Resolution stated in percent are referenced to measured or selected value unless otherwise stated.

Where resolution exceeds accuracy, resolution takes precedence.

Specifications and features are subject to change without notice.

RF SIGNAL GENERATOR

Frequency	
Range:	250 kHz to 999.9999 MHz
Resolution:	100 Hz
Accuracy:	*Same as Master Oscillator*
Supplemental Characteristic	
Tunable Range:	Tunable from 100 Hz to 999.9999 MHz (characteristic below 250 kHz are not specified)

Output (T/R and AUX RF Connectors)	
Range (T/R):	-130 to -20 dBm (Simplex Mode) -130 to -40 dBm (Duplex Mode)
Range (AUX):	-130 to -13 dBm
Resolution:	0.1 dB
Accuracy:	±2 dB (>-90.0 dBm, <400 MHz) ±2.5 dB otherwise
VSWR:	<1.15:1 (0.25 to ≤100 MHz) <1.23:1 (>100 to ≤400 MHz) <1.38:1 (>400 MHz)
Spectral Purity	
Residual FM:	<20 Hz (rms, 0.3 to 3 kHz BW)
Residual AM:	<0.5% (rms, 0.3 to 3 kHz BW)
Harmonics:	<-26 dBc
Non Harmonics:	<-50 dBc (≤1000 MHz) <-40 dBc (>1000 MHz)
Input Protection (T/R):	50 W CW continuous 100 W CW (90 sec/3 min) 150 W CW (30 sec/3 min) 200 W CW (15 sec/3 min)
(AUX):	Up to 0.25 W

MODULATION

Frequency Modulation

Range:	100 Hz to 100 kHz
Resolution:	10 Hz (0.01 to 2.55 kHz) 50 Hz (2.60 to 12.75 kHz)
Accuracy:	±5% + residual FM, (1 kHz rate, GEN1, GEN 2, EXT MOD) ±10% + residual FM (DATA GEN) ±15% + residual (DTMF GEN)
Distortion:	<2% (1 kHz sine wave, 10 kHz deviation, 0.3 to 3 kHz BW)

Supplemental Characteristic

Rate:	10 Hz to 20 kHz-FSK rates up to 40 kbps
EXT MOD Sensitivity	2 kHz/Vpk ±10% (FM Narrow) 10 kHz/Vpk ±10% (FM Wide)

Amplitude Modulation:

Range:	30% to 90%
Resolution	1%
Accuracy:	±5% + residual AM (1 kHz rate, GEN1, GEN2, EXT MOD, ≤400 MHz and <+7 dBm or >400 MHz and <0 dBm) ±15% + residual AM (DTMF GEN, ≤400 MHz and <+7 dBm or >400 MHz, <0 dBm)
Distortion:	<2% (30% to 90% modulation, 1 kHz rate, 0.3 kHz BW)
EXT MOD Sensitivity:	9% to 11% Vpk

Supplemental Characteristic

Rate:	100 Hz to 10 kHz

Phase Modulation

Range:	0.1 to 10 radians peak
Resolution:	0.1 radians
Accuracy:	±5% + residual PM (1 kHz rate, GEN1, GEN2, EXT MOD) ±15% + residual PM (DTMF GEN)
EXT MOD Sensitivity:	2 rad/Vpk±10%

Supplemental Characteristic

Rate:	100 Hz to 6 kHz

AUDIO/DATA GENERATORS

A.F. Generator #1

Frequency Range:	5 Hz to 20 kHz (sine wave only) 5 Hz to 10 kHz (other wave shapes)
Frequency Resolution:	0.1 Hz
Frequency Accuracy:	*Same as Master Oscillator ±0.1 Hz*
Output Range (High Lvl):	0.01 to 2.5 Vpk (into 150 Ω)
Output Resolution (High Lvl):	0.01 Vpk

Output Accuracy (High Lvl):	±3% full range ±5 mVpk (≤10 kHz, ≥0.03 Vpk) ±7% full range ±5 mVpk (>10 kHz, ≥0.03 Vpk)
Output Rang (Low Lvl):	0.1 to 250 mVpk (into 150 Ω)
Output Resolution (Low Lvl):	0.1 mV
Output Accuracy (Low Lvl):	±4% full range ±0.25 mVpk (≤10 kHz, 0.03 Vpk) <level ≥1 mVpk) ±7% full range ±0.25 mVpk (>10 kHz, 0.03 Vpk <level ≥1 mVpk)
THD:	<0.7% (1 kHz sine wave, 2.5 Vpk, 150 Ω Load) <1% (all other frequencies and levels)
Wave Shape:	Sine, Ramp, Square, Triangle

A.F. Generator #2

Frequency Range:	1 kHz (sine wave)
Frequency Accuracy:	±0.2 Hz
Output Range (High Lvl):	0.01 to 2.5 Vpk (into 150 Ω)
Output Resolution (High Lvl):	0.01 Vpk
Output Accuracy (High Lvl):	±3% full range ±5 mVpk (≥0.03 Vpk)
Output Range (Low Lvl):	0.1 to 250 mVpk (into 150 Ω)
Output Resolution (Low Lvl):	1 mV
Output Accuracy (Low Lvl):	±4% full range ±0.25 mVpk (0.03 Vpk) <level ≥1 mVpk)

DTMF Generator

Output Range (High Lvl):	0.01 to 2.5 Vpk (into 150 Ω)
Output Resolution (High Lvl):	0.01 Vpk
Output Accuracy (High Lvl):	±10% full range ±5 mVpk (≥0.03 Vpk)
Output Range (Low Lvl):	0.1 to 25 mVpk (into 150 Ω)
Output Resolution (Low Lvl):	0.1 mV
Output Accuracy (Low Lvl):	±10% full range ±0.25 mVpk (0.03 Vpk) <level ≥1 mVpk)
Modes:	Continuous, Single Shot

Supplemental Characteristics

Digits:	16 (0-9, *, #, A, B, C, D)
Mark/Space Timing:	25 to 999 ms
Mark/Space Timing Resolution:	1 ms
Mark/Space Accuracy:	±20%

RECEIVER

Frequency

Range:	250 kHz to 999.9999 MHz
Resolution:	100 Hz

Supplemental Characteristic

Tunable Range:	Tunable from 100 Hz to 999.9999 MHz (characteristics below 250 kHz are not specified)
Sensitivity:	2 µV (10 dB SINAD, >2 MHz, 1 kHz tone, 3.3 kHz deviation, 15 kHz IF BW, C-Message weighted filter, 10 kHz FM deviation meter range, 15°C≤ to ≤35°C) ≤2.5 µV otherwise
Antenna Input Protection:	10 W CW (5 sec with alarm)
Selectivity:	300 kHz, 15 kHz

Supplemental Characteristic

Adjacent Channel Rejection:

RX BW (3.0 dB)	>30.0 dB Down
300 kHz	±485 kHz
15 kHz	±15 kHz

Demodulation Output

FM:	0.20 Vpk/kHz ±10% (10 kHz range)
	0.10 Vpk/kHz ±10% (20 kHz range)
	0.04 Vpk/kHz ±10% (50 kHz range)
	0.02 Vpk/kHz ±10% (100 kHz range)
AM:	1.13 ±0.06 Vrms (80% modulation)
ØM:	0.2 Vpk/Rad ±10%

SELECTIVE RF COUNTER

Frequency Range:	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)

Supplemental Characteristic

Tunable Range:	100 Hz to 999.9999 MHz (characteristics below 250 kHz are not specified)
Resolution:	1 Hz
Accuracy:	*Same as Master Oscillator ±2 Hz*
RF Level:	0 to 53 dBm (T/R Connector) -60 to 0 dBm (Antenna Connector)

RF FREQUENCY ERROR METER

Meter Range:	0 Hz to 100 kHz
Meter Accuracy;	*Same as Master Oscillator ±2 counts*
Meter Resolution:	1 Hz (10 sec gate time) 10 Hz (1 sec gate time)

RF Frequency Range:	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)
RF Level:	0 to 53 dBm (T/R Connector) -60 to 0 dBm (Antenna Connector)

AF FREQUENCY COUNTER

Frequency	
Range:	10 Hz to 20 kHz
Accuracy:	*Same as Master Oscillator ±1 counts*
Resolution (1 sec gate time):	0.1 Hz (1 sec gate time, 10 to 500 Hz) 1 Hz (1 sec gate time, >500 Hz to 20 kHz) 0.1 Hz (10 sec gate time)
Supplemental Characteristic	
Input Signal Level	
SCOPE/DVM Input:	90 mVpp (50 mV range, any waveform) 450 mVpp (any waveform)

FREQUENCY MODULATION METER

Range:	10 kHz, 20 kHz, 50 kHz, 100 kHz full scale
Resolution:	10 Hz (10 kHz range) 100 Hz (20 kHz, 50 kHz, 100 kHz ranges)
Accuracy:	±5% full scale ±50 Hz ±1 count + source residual FM (300 kHz IF BW, 1 kHz tone, 5 kHz deviation, C-message weighted filter)
Modulation Rate:	0 to 20 kHz
Carrier Range:	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)
Carrier Level:	0 to 53 dBm (T/R Connector) -60 to 0 dBm (Antenna Connector)

ØMODULATION METER

Range:	1, 2, 5, 10 rad peak full scale
Resolution:	0.01 rad (1 and 2 radian ranges) 0.1 rad (5 and 10 radian ranges)
Accuracy:	±5% of full scale ±0.1 rad ±1 count + source residual PM (300 kHz IF BW, 1 kHz tone, 1 rad deviation, C-message weighted filter)
Modulation Rate:	100 Hz to 6 kHz
Carrier Range:	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)
Carrier Level:	0 to 53 dBm (T/R Connector) -60 to 0 dBm (Antenna Connector)

AM MODULATION METER

Range:	1% to 100%
Resolution:	0.1%
Accuracy:	±5% of full scale ±1 count + source residual AM (300 kHz IF BW, 1 kHz tone, 50% AM depth, C-Message weighted filter)
Modulation Rate:	50 Hz to 10 kHz
Carrier Range:	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)
Carrier Level:	0 to 53 dBm (T/R Connector) -60 to 0 dBm (Antenna Connector)
Supplemental Characteristic	
AGC Attack Time:	50 ms

RF POWER METER

Meter Ranges:	2 mW to 200 W in a 1-2-5 sequence
Resolution:	1% of full scale or 0.1 mW whichever is greater
Accuracy:	±10% ±0.1 mW ±1 count (>200 mW or temperature 15°C to 3°C) ±15% ±0.1 mW ±1 count (<200 mW or 15°C < temperature ≤35°C)
Frequency Range:	1.5 to 999.9999 MHz
RF Level Range:	2 mW to 200 W average power
Supplemental Characteristic	
Usable Level:	0.2 mW to 200 W average power (characteristics below 2 mV not specified)
Operating Conditions:	50 W CW continuous (50°C) 100 W CW (90 sec/3 min, 50°C) 150 W CW (30 sec/3 min, 50°C) 200 W CW (15 sec/3 min, 50°C)
VSWR:	1.15:1 (0.25 to 100 MHz) 1.23:1 (100 to 400 MHz) 1.38:1 (>400 MHz to 999.9999 MHz)
Alarms:	Audible and visual (if applied power exceeds 200 W in the 200 W range or temperature exceeds 105°C)

RECEIVE LEVEL METER

Range:	-101 to -30 dBm (15 kHz IF BW) -80 to -30 dBm (300 kHz IF BW)
Supplemental Characteristic	
Accuracy:	±3 dB
Frequency Range	250 kHz to 999.9999 MHz (The received frequency must be within the IF bandpass of the COM-120B.)

DISTORTION METER

Range:	1% to 20%
Resolution:	0.1%
Accuracy:	±0.5% distortion ±1 count (1% to 10%) ±2% distortion ±1 count (>10 to 20%)
Signal Frequency:	1 kHz
Supplemental Characteristic	
Signal Level:	0.03 to 200 Vrms (SCOPE/DVM input) 0.15 to 15 Vrms (AUDIO/DATA input)

SINAD METER

Range:	3 to 30 dB
Resolution:	0.1 dB
Accuracy:	±1 dB ±1 count (at 12 dB)
Signal Frequency:	1 kHz
Supplemental Characteristic	
Signal Level:	0.03 to 200 Vrms (SCOPE/DVM input) 0.15 to 15 Vrms (AUDIO/DATA input)

DIGITAL VOLTMETER

Ranges:	50 mV to 200 V in a 1-2-5 sequence
Range (DC):	10 mV to 200 Vdc (SCOPE/DVM input)
(AC):	10 mV to 200 Vrms (SCOPE/DVM input) 150 mV to 15 Vrms (AUDIO/DATA input)
Meter Ranges:	50 mV to 200 V (1-2-5 sequence)
Resolution:	3.5 digit
Accuracy:	±5% full scale ±5 mV ±1 count (SCOPE/DVM input) ±7% full scale ±5 mV ±1 count (AUDIO/DATA input)

OSCILLOSCOPE

Bandwidth (3 dB):	50 kHz
Vertical	
Ranges:	10 mV to 200 V per division (1-2-5 sequence)
Max Input Voltage:	200 Vpk
Accuracy:	5% full scale
Resolution:	1% full scale
Coupling:	DC, AC and GND
Supplemental Characteristic	
Resolution	256 data points, 8 major divisions
Horizontal	
Ranges:	100 µsec to 100 ms per division (1-2-5 sequence)
Resolution:	1% full scale
Accuracy:	1% full scale
Supplemental Characteristic	
Resolution:	500 data points, 10 major divisions
Impedance:	1 MΩ, unbalanced

SPECTRUM ANALYZER

Center Frequency:	250 kHz to 999.9999 MHz
Supplemental Characteristic	
Tunable Range:	100 Hz to 999.9999 MHz (characteristics below 250 kHz are not specified)
Resolution:	100 Hz
Frequency Span	
Ranges:	1 kHz to 100 MHz per division in a 1-2-5 sequence + zero span
Accuracy:	±5% of span width
Operation Modes:	Normal, Split Screen
Frequency Span Modes:	

Scan Width	Resolution Bandwidth
100 MHz	3 MHz
50 MHz	3 MHz
20 MHz	3 MHz
10 MHz	3 MHz
5 MHz	300 kHz
2 MHz	300 kHz
1 MHz	300 kHz
500 kHz	30 kHz
200 kHz	30 kHz
100 kHz	30 kHz
50 kHz	30 kHz
20 kHz	3 kHz
10 kHz	3 kHz
5 kHz	3 kHz
2 kHz	300 Hz
1 kHz	300 Hz
0 kHz	30 kHz

Level

Display:	Log, 2 and 10 dB per division
Vertical Resolution:	1 dB
Range (Dynamic):	60 dB
Bandwidth Switching Error:	<3 dB
Log Linearity:	±2 dB (referenced to -40 dBm) ±3 dB (≤15°C, ≥35°C)
Input Attenuator:	0, 30 dB (Antenna Connector)

INPUT/OUTPUT CONNECTORS

RS-232 Connector

Operations Mode:	Off, PC (Input/Output)
Baud Rates:	100, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400
Stop Bits:	1, 2
Parity:	Odd, Even, None
Handshake:	None, Xon/Xoff, CTS/RTS

MASTER OSCILLATOR

TCXO

Frequency:	10 MHz
Uncertainty:	±0.1 PPM
Temperature Stability:	±0.2 PPM (0°C to 50°C)
Aging:	±0.5 PPM/year

POWER REQUIREMENTS

Line Voltage:	90 to 135 VAC (50 to 400 Hz) 200 to 265 VAC (50 to 60 Hz)
DC Input:	12 to 30 Vdc
Power Consumption	
AC:	180 W maximum
DC:	150 W maximum
Supplemental Characteristic	
Power Consumption	
(AC):	110 W typical
(DC):	90 W typical

GENERAL CHARACTERISTICS

Operating Temperatures	0° to 50°C
Dimensions:	40.0 cm (15.75") wide, 19.0 cm (7.5") high, 42.9 cm (16.875") deep (without bail handle and front panel cover)
	44.0 cm (17.32") wide, 19.0 cm (7.5") high, 53.7 cm (21.125") deep (with bail handle and front panel cover)
Weight:	17.3 kg (38.5 lbs) (without options, lid, accessories)

VENTILATION REQUIREMENTS

CAUTION: KEEP ALL VENT OPENINGS CLEAR AND UNOBSTRUCTED FOR PROPER EQUIPMENT COOLING AND CONTINUED RELIABILITY. WHEN OPERATING THE EQUIPMENT IN THE NORMAL HORIZONTAL POSITION, MAINTAIN AT LEAST TWO INCHES (=FIVE CENTIMETERS) OF CLEARANCE BETWEEN THE EQUIPMENT SIDE WITH EXHAUST FAN AND OBJECTS OR WALLS. IF OPERATING IN A RACK, MAXIMUM AMBIENT TEMPERATURE MUST BE AT OR BELOW 40°C.

OPTIONS

01 Internal Battery. Provides self-contained power.

02 0.01 PPM Oven Time Base. The oven time base replaces the standard TCXO and is recommended for customers maintaining 800/900 MHz systems.

03 30 kHz IF Filter. The 30 kHz filter is required when ordering Option 15.

04 #2 Variable Function Generator. The generator replaces the standard fixed 1 kHz generator.

05 Generate Amplifier. An internal 26 dB amplifier for those requiring additional RF output level.

07 Data Generator/BER Meter. The Data Generator/Bit Error Rate Meter is available for testing digital characteristics of transceivers.

08 SSB Receive Filter. The SSB filter is available for customers requiring the capability to monitor SSB signals.

09 RCC Signaling. Provides MTS, IMTS and Tone Remote Control signaling.

11 Audio/Digital Signaling. Provides encode/decode capability for the following formats:

CCIR	EURO
DZVEI	NATEL
EEA	CCIRH
5/6 Tone	DDZVEI
ZVEI	EIA
POCSAG	

12 Tracking Generator. Tracking Generator and Spectrum Analyzer provide amplitude vs. frequency display when sweeping cavities, duplexors, etc.

13 IEEE 488. Provides the parallel GPIB interface.

14 CLEARCHANNEL LTR*. Provides test capability for LTR repeaters and mobiles.

15 AMPS Mobile Station Test. Auto and manual test facilities to verify proper operation of AMPS mobiles, transportables and portables.

16 EDACS*. Provides test capability for EDACS repeaters and mobiles.

NOTES